Monitoring and Control of Risks Associated with Food Production and Food handling: the HACCP System and its Application to the Food Businesses with Particular Regard to Cyprus

by

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LIST OF ACRONYMS AND ABBREVIATIONS

AEI	Advanced Educational Institutions
a_w	Water Activity
BSE	Bovine Spongiform Encephalopathy
CCP	Critical Control Point
ELOT	Hellenic Organisation for Standardisation
ETA	Event-Tree Analysis
EEC	European Economic Communit
EU	European Union (formerly European Economic Community (EEC))
FAO	Food and Agriculture Organisation
FDA	Food and Drug Administration
FSIS	Food Safety and Inspection Service
FMEA	Failure Mode and Effect Analysis
FTA	Fault-Tree Analysis
GHP	Good Hygiene Practice
GMP	Good Manufacturing Practice
HAZOP	Hazard Operability
HMSO	Her Majesty's Stationery Office
ICMFS	International Commission of Microbiological Specifications for Foods
ISO	International Standard Organisation
MAFF	Ministry of Agriculture, Fisheries and Food
NACMCF	National Advisory Committee on the Microbiological Criteria for Foods
SOP	Standard Operating Procedure
SPSS	Statistical Package for Social Sciences
SSOP	Standard Sanitary Operation Procedure
TEI	Technical Educational Institutions
TQM	Total Quality Management
TSE	Transmissible Spongiform Encephalopathies
UK	United Kingdom
US	United States of America
USDA	United States Department of Agriculture
WHO	World Health Organisation

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ABSTRACT

A harmonised approach to food safety across the EU, including the Accession States, is essential to meet growing public concerns. For the Cyprus economy dependant on tourism, high confidence in the safety of its food is vital.

The emphasis in the present research has been on factors that influence the implementation of food safety procedures in Cyprus. The investigation has concentrated on a particular approach to ensuring food safety known as HACCP. There has been no previous research on this topic in Cyprus. The principal methodology was the application of specifically designed questionnaires combined with personal interviews and literature based evaluations. Seven percent of the total food businesses in Cyprus were surveyed. Very unusually for studies of this nature the participation rate was approaching 100%.

The key factors for implementation of the HACCP system in Cyprus that have been identified in this survey are as follows:

- The degree of understanding of food safety and of the HACCP system by each food business. The level of education was inversely correlated with the number of mistakes the respondents made in identifying the most important hazards,
- The commitment of businesses and the resources available to implement food safety measures. The size of the business was shown to correlate directly with their implementation of the HACCP system and
- The ability to gain access to appropriate expertise. This was a major problem, particularly, for small businesses.

The results were compared with those of a study conducted in Crete. The similarity of the results indicated that legislation was not a key factor for the HACCP system implementation.

1. INTRODUCTION

1.1 Ensuring food safety

Food is essential both for growth and for the maintenance of life. It provides the human body with energy, which is vital for its existence. Food is also responsible for ill-health in two ways; failure to consume the right kind of food in sufficient quantity and the consumption of food containing hazards which can lead to an illness. Hazard is "a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect" (Codex Alimentarius, 1997: 34). The most important hazards concerning food are described in details in Chapter 2 and Appendix C.

Eating habits have undergone a major change over the last two decades and new food production, preparation and distribution techniques have developed to accommodate these trends. Food industries are increasing in complexity and size throughout the world in their effort to incorporate these changes in their processes. Besides innovations in packaging, formulations and distribution systems, large food companies have shifted to highly automated, high-speed operations. Many food products today are produced in huge quantities and are shipped almost immediately after production to distribution centres or chain warehouses and may be purchased by consumers a very short time after production. This time period may be so short in some instances that the laboratory tests cannot be completed in time to forestall a bad product from getting into the consumers' hands (Bauman, 1993). This centralisation and globalisation of foods increases the likelihood of epidemics of foodborne diseases (Sanders, 1999).

These enormous and important changes make the spread of illness around the world easier. It is obvious then, that utilisation of a superior system of control is of paramount importance (Bauman, 1993). Effective hygiene control is vital to avoid the adverse human health and economic consequences of foodborne illness, foodborne injury and food spoilage.

Foodborne diseases are an important health problem in both developed and developing countries. A joint WHO / FAO (World Health Organisation / Food and Food and Agriculture Organisation) expert committee on food safety observed that illness due to contaminated food is probably the most widespread health problem in the contemporary world (WHO, 1984). Although their health and economic impacts are never fully appreciated because of insufficient data (WHO, 1984), outbreaks of foodborne illness can damage trade and tourism and lead to economic losses, unemployment and litigation. Food spoilage is also very costly as huge quantities of food are destroyed and can adversely affect trade and consumer confidence.

All these adverse health effects have to do only with the consumption of contaminated food where the results can be seen acutely (often in less than a week). However, there are problems arising from the consumption of food, for example, aflatoxins which can cause long-term health effects (liver cancer). These problems usually appear many years after the consumption of food and most of the times are the result of repeated consumption of such food.

A review of 212 investigated and published Salmonella outbreaks occurring mainly in the industrialised countries indicate that industrially produced food accounts for less than 5% of outbreaks (Motarjemi & Kaferstein, 1999). It depends, however, on storage time and conditions of food. The great majority of outbreaks resulting from preparation of food in homes or in small food service establishments are not investigated and published. Taking this into consideration, it may be concluded that the number of outbreaks related to industrially produced food is below 5%, perhaps less than 1% (WHO, 1998a).

In a survey carried out in 1995 and 1996, 19356 adult consumers in eight US states were asked various questions related to food handling and food consumption practices. Overall, 19% of respondents did not adequately wash hands or cutting boards after contact with raw meat or chicken (Altekruse *et al*, 1999). Furthermore, the survey revealed that 20% ate pink hamburgers, 50% ate undercooked eggs, 8% ate raw oysters and 1% drank raw milk (Altekruse *et al*, 1999).

As the important role of food safety and food hygiene has become well understood by scientists, efforts have been directed towards the development and application of such systems that would lead to the production, preparation and delivery to consumers of safe foods.

For many years, international bodies like WHO, FAO and the European Union have been dealing with food safety and food hygiene. WHO and FAO created an executive organ, the Codex Alimentarius Commission. A number of standards, guidelines and recommendations were adopted by the Codex Alimentarius Commission to protect the health of consumers (see Chapter 2.3). Furthermore, the European Union adopted on 19th June 1993 the 93/43/EEC Directive on the Hygiene of Foodstuffs. This Directive introduced the HACCP (Hazard Analysis Critical Control Point) concept (see Chapter 2.2.2) into the European food legislation. The HACCP system particularly in the context of Cyprus is the subject of the present work and is analysed in full details in following chapters.

There are many methods / techniques other than the HACCP system for ensuring food safety with a various degree of success such as Good Hygiene Practices / Good Manufacturing Practices, Assured Safe Catering, Supplier Quality Assurance and Standard Operating Procedures (SOP's). These can also be used prior to the development and implementation of the HACCP system. They are called prerequisites of the HACCP system and are characterised as the foundation of it. However, their implementation gives a degree of safeness to the products as some basic food safety requirements (e.g. temperature control, cleaning schedules, training of the food handlers etc) are implemented.

Other techniques such as HAZOP (Hazard Operability), Event-Tree Analysis (ETA) and Fault-Tree Analysis (FTA) which are used by the engineering industry may also be used in the food industry with some modifications.

HAZOP was initially developed by ICI Ltd in the UK in the late 1960's (Swann & Preston, 1995). It is a highly structured method which tries to identify all possible deviations from the way a system is designed to operate and to identify all hazards associated with these deviations. It builds upon the principle that a problem can only arise when there is a deviation from the intention of the system (Fencott & Hebbron, 1995). Kennedy and Kirwan (1998) concluded that the HAZOP approach aims to identify detailed and realistic vulnerabilities and the means for their prevention intending both for risk assessment and risk control. This system requires close co-operation between designers, representatives from service and production departments and the shop floor (Swuste *et al*, 1997).

There is also the Failure Mode and Effect Analysis system (FMEA). This method was developed and implemented for the first time in 1949 by the United States Army (Scipioni *et al*, 2002) which looks at the possible failure modes, the contributory cause(s) of the failure and considers what effects would be. It then considers the current control and recommends any additional controls required. It is a system which depends on teamwork and can be used to increase the effectiveness of the HACCP system (Mortimore & Wallace, 1994).

The above techniques (HAZOP, ETA, FTA) can be used instead in the food industry, however, only FMEA is perhaps the most appropriate for challenging the HACCP system (Mortimore & Wallace, 1994).

1.2 The aims and objectives of the current research

The production of safe food is of fundamental importance for the food businesses, governments and consumers all over the world. However, dramatic changes in food production, processing, distribution, and the rapid increase in international trade in food products, made the application of an effective food safety control system (e.g. HACCP) increasingly a necessity.

As noted earlier in this chapter, HACCP is an internationally recognised food safety management system. However, it is not widely used. A survey carried out across the manufacturing, retail and catering sectors of the UK food industry showed that 69%

of manufacturers, 13% of retailers and 15% of caterers were using the HACCP system (Mortlock *et al*, 1999).

Unfortunately, the existing data, about food hygiene management across the Cyprus food sector and, more specifically, the application of the HACCP system, is very limited. Most of the surveys that exist were carried out by governmental departments and are classified as confidential. Thus, it is very difficult to retrieve any information from such surveys. Moreover, surveys often use local rather than national samples or have focused on one sector of industry. The only information that is available is the announcements regarding the HACCP system certification implemented by certain food businesses. An example is the Cyprus Airways Catering Department which was awarded the HACCP system Certification after successful auditing of its system (Sunjet, 2003).

As a consequence of the author's identification of the problem (i.e. lack of information), it was decided that a survey of food businesses in Cyprus should be carried out. The aim of this research is to investigate food safety issues among businesses in Eastern Mediterranean countries, especially Cyprus.

For comparison purposes, it seemed appropriate to carry out a smaller investigation in Heraklion County of Crete, Greece. It was considered of value to compare the state of food safety in these countries with the findings of similar surveys carried out in the UK, other European countries and the US.

Specific objectives of this work are to:

(a) Determine the hygiene status of the food businesses,
(b) Identify the respondents level of knowledge about food safety / hygiene and the HACCP system,
(c) Identify the level of implementation of the HACCP system,
(d) Identify the training needs of food handlers,
(e) Suggest measures in order to:
    - Improve the knowledge of food handlers about food safety / hygiene and the HACCP system and

- Promote wider implementation of HACCP in all food businesses and especially of the small and medium sized food businesses.

The promotion of the hygienic status of the food businesses in Cyprus and the implementation of the HACCP system will be beneficial for the whole country. Cyprus relies heavily on its tourism sector. It is a pre-accession state, thus the Cyprus legislation is now fully harmonised with the EU legislation. In the EU Directive 93/43/EEC on the "Hygiene of Foodstuffs" there is the requirement of implementing the HACCP system in all food businesses. The HACCP system implementation should, in principle, be beneficial for the whole food sector in Cyprus because it will:

(a) Decrease the number of food poisoning cases and outbreaks that might occur on the island,

(b) Help the authorities in carrying out sanitary inspections of food businesses and

(c) Provide reassurance to the tour operators for food safety of the Cyprus food industry which will enhance the possibility of increasing the number of tourists visiting Cyprus and reduce the risk that the excellent reputation of Cyprus could be damaged by a food poisoning outbreak.

This is very important because in Cyprus the small and medium sized food businesses represent the majority of food businesses and quantitatively play a prominent part in the food supply. However, they appear to represent one of the highest risks to consumers (Morrison *et al*, 1998).

2. HAZARD ANALYSIS CRITICAL CONTROL POINT SYSTEM (HACCP) SYSTEM: LITERATE SURVEY

Hazard Analysis Critical Control Point System (HACCP) is a science-based, systematic and documented system that permits the identification of hazards and the assessment of the likelihood of their occurrence throughout the whole food chain, from primary production to final consumption. The HACCP system is a proactive process in that it relies on the principle that "prevention is better than cure" as it focuses on prevention rather than relying mainly on end product testing. End product testing is time consuming and very costly. Moreover, end product testing cannot be 100% accurate or secure that the food produced is absolutely safe for human consumption.

HACCP is a structured method for hazard identification and control. The Hazard Analysis portion of HACCP involves a systematic study of the ingredients, the food product, the conditions of processing, handling, storage, packaging, distribution and consumer use (Bauman, 1993). Furthermore, the application of HACCP is compatible with the implementation of food safety and / or quality management systems, such as the ISO 9000 series, Good Manufacturing Practices (GMP), Total Quality Management (TQM) and Standard Sanitary Operation Procedures (SSOP).

2.1 Historic perspective on the HACCP system development

From the time that astronauts were first sent into space, a problem was identified. The problem was to provide safe food for astronauts. Safe in this context means that the food has to be 100% safe for human consumption. Food must not be contaminated with bacterial or viral pathogens, toxins, chemicals, or physical hazards. It had been agreed that no risks could be tolerated when feeding astronauts (Struijk, 1996) that could cause an illness or injury. Such hazards might result in an aborted or catastrophic mission (Bauman, 1992). The prospect of astronauts suffering food poisoning in a space suit during a mission was just unthinkable, even without the added problem of weightlessness (Barrow, 1997). Moreover, as there was no knowledge of the reactive properties of foods, especially particulates under zero gravity, the problem was considered to be potentially a major one.

The beginnings of the HACCP system started in 1959 when the Pillsbury Company – a food manufacturing industry in Minnesota – was asked to produce food that could be used under zero gravity in the space capsules. In this effort, the Pillsbury Company, the National Aeronautics and Space Agency (NASA), the Natick Laboratories of the US Army and the US Air Force Space Laboratory Project Group co-operated.

However, the existing techniques and methods of quality control could not provide sufficient evidence that the food produced was safe. The testing of the whole final products was not possible.

On the other hand, the use of sampling methods was considered to have its disadvantages, as the possibility of detecting a hazard in a sample depends on two factors:

(a) The ability of the analytical technique to detect the hazard that may be present in the final product and
(b) The likelihood that the hazard occurs in the actual sample chosen for analysis.

Furthermore, analytical methods vary in their sensitivity, specificity, reliability and reproducibility (Mortimore & Wallace, 1994). The other main factors that influenced the ability to determine a hazard in a sample taken from a batch were:

(a) The distribution of the hazard in the batch and
(b) The frequency at which the hazard occurs in the batch.

In most cases, the distribution of biological hazards in the food is heterogeneous. The detection of a hazard distributed in this way is very difficult (Mortimore & Wallace, 1994).

Thus, efforts were driven towards the development of new systems and techniques that would ensure as safer food as possible. At that time most food industries in USA were not using a uniform approach or even had an understanding as to what constituted a programme for safe food production (Bauman, 1993).

In their search to find similar systems and programmes being used to identify defects of products, they identified that NASA was using the "zero defects programme" for checking the hardware programmes. This programme comprised a series of tests, such as x-ray and ultrasound, which were not destructive for the hardware. However, in the case of food testing these were destructive so they were unsuitable for the assurance of food safety.

Through an extensive and in depth evaluation of the problem, it was decided that a different approach should be used. The experts concluded that the only possible way that could guarantee the production of safe food was to develop and apply a preventative system. So, they embarked on the development of such a programme. This programme included the control of raw materials, processes, environment, personnel, storage and distribution. Thus all production stages needed to be checked to identify hazards that might cause food contamination. This approach resulted in the development of the HACCP system.

If this programme was implemented correctly, then there would not be end-product testing except those tests for monitoring purposes (Bauman, 1992). Furthermore, record keeping was a vital prerequisite of NASA and this helped in the development of the HACCP system, as there was a fully recorded background.

In addition to these records, NASA also required record keeping for all the new materials used, the plant where the food was produced, the names of people involved in the production and any other information related to the production of food. All the information gathered might contribute to the history of the product.

The problem at this point was that what should be done was known, but the way to achieve it was unknown. Those involved did not know how to do an adequate hazard analysis. Subsequently, it became known that the US Army Natick Research Development and Engineering Centre had developed a system of analysis called "modes of failure" for the analysis of medical supplies. Some modifications made it suitable for the hazard analysis in a food production process. It was decided that if the production chain was broken down in its components (various processes) and its products (raw materials, ingredients), then the work was easier and more efficient (Bauman, 1993).

At all stages, the main aim was to identify the potential points that could influence to food safety. When this break down was completed, the understanding of the connection of all these components with each other was recognised as necessary in order to develop the HACCP system.

Through this in depth analysis, critical points were identified, checked and monitored. Thus, in order to apply a successful HACCP system, there is the need to know all the details relating to the product that will be produced.

The HACCP system was first presented publicly during the 1971 US National Conference on Food Protection (US Department of Health, Education and Welfare, 1972). In that Conference, panels of experts were set up to prepare preliminary position papers on the problem of microbiological contamination of foods. Each panel had different topics to cover. In one panel, a representative of the Pillsbury Company presented the HACCP system. The topic of this panel was "the prevention of contamination of commercially processed foods" (US Department of Health, Education and Welfare, 1972: 57). The panel agreed that the existing laboratory techniques were not sufficient enough to produce safe foods, so a system for hazards analysis had to be developed. Detailed knowledge of each stage of the food chain could have led to the selection of the "critical control points". Critical control point was defined as "the location(s) or point(s) in a food processing operation at which failure to prevent contamination can be detected by laboratory tests with maximum assurance and efficiency" (US Department of Health, Education and Welfare, 1972: 68).

Critical Control Points were examined by dividing them to the following categories:

- Raw materials CCPs,

- Processing CCPs,
- Environment CCPs,
- Personnel CCPs and
- Finished product CCPs.

The outcome of the work was the concept of hazards analysis of each food and food system and the establishment of critical control points to ensure quality. Recommendations were made for a more consistent methodology, including a sound sampling procedure and identification of microorganisms and factors of concern. It was also pointed out that zero tolerance was impossible and that levels of a non-hazardous nature should be determined. In other words, a Hazard Analysis Critical Control Point system (HACCP) was established as a result of this conference.

Following this conference, Food and Drug Administration (FDA) awarded the Pillsbury Company a contract to conduct classes for FDA personnel on the HACCP system. The first comprehensive document on HACCP was published by the Pillsbury Company, in 1973, and was used for training FDA inspectors in HACCP principles (US Department of Health, Education and Welfare, 1972). A special session was held with personnel involved in FDA's acidified and low-acid canned food regulation. This group developed the necessary information for the promulgation of the acidified and low acid canned food regulation which is a successful HACCP system (US Department of Health, Education and Welfare, 1972).

The HACCP system had been used in the plants of the Pillsbury Company since 1971. During the 1970s and early 1980s a number of companies requested and were given information and help in establishing their own HACCP programmes.

In the 1980s, the International Commission on Microbiological Specifications for Foods (formed in 1962 under the aegis of the International Union of Microbiologists) did a considerable amount of work on the HACCP system. The aim of this Commission is to ensure microbiological safety and quality of foods in international trade (International Commission of Microbiological Specifications for Foods, 1988).

The Commission prepared a document for the WHO. This document, "Report of WHO / ICMFS – Meeting of Hazard Analysis: Critical Control Point System in Food Hygiene", defined the basic principles of the HACCP concept (Bryan, 1999).

It was not until 1985 that the HACCP system was seriously considered for broad application in the US food industry. In 1985, the US National Academy of Sciences (NAS) recommended the HACCP system in the publication "An evaluation of the microbiological criteria for foods and food ingredients" (Pierson and Corlett, 1992). They concluded that a preventative system (HACCP) was essential for the control of microbiological hazards. They also concluded that the current procedure of end product testing was not adequate to prevent foodborne disease.

In 1986, the US Congress asked from the National Marine Fisheries Service to develop a programme that could be used for the inspection of the fish production units based on the HACCP principles (Garrett & Hudak-Roos, 1991; Bauman, 1992).

In 1987, the US National Oceanic and Atmospheric Administration (NOAA) was charged by Congress to design a programme of certification and surveillance to improve the inspection of fish and seafood consistent with the HACCP (Bauman, 1992).

The same year, the US National Advisory Committee on the Microbiological Criteria for Foods (US NACMCF) was established. The Committee refined HACCP by adding to it appropriate descriptions of what each principle involves. They also developed definitions of terminology used in HACCP. They also provided information on how inspections had to be carried out by the inspectors of the United States Department of Agriculture (USDA) and FDA (Garrett & Hudak-Roos, 1991; Bauman, 1992 and1993).

In 1988, the ICMFS published "HACCP in Microbiological Safety and Quality" (Tzia and Tsiapouris, 1996). In this publication, the definition of the HACCP system, its principles and ways of application were developed. This was the first time that an international body disseminated view on the HACCP system.

At the end of 1989, the US NACMCF published a guideline for the application of HACCP. This publication included the 7 principles of HACCP with their analysis and 6 categories of hazards (Tzia and Tsiapouris, 1996). The same year, the EU published the Directive 89/397/EEC on the Official Control of Foodstuffs.

In 1992, the US NACMCF published a revised edition of the 1989s guide taking into account a draft paper of the Codex Alimentarius Committee on Food Hygiene published in 1991, in which the HACCP system was examined. In this guide, a decision tree for the identification of the CCPs was presented.

In the early 1990's, the European Union published a number of Directives to promote food safety, such as:

- 91/684/EEC on eggs,
- 91/493/EEC on fish,
- 92/46/EEC on milk and milk products and
- 92/5/EEC on meat products.

In the last three Directives (91/684/EEC, 92/46/EEC and 92/5/EEC), a general provision is made requiring persons responsible for an establishment to "carry out their own checks based on the following principles:

- Identification of critical points in their establishment on the basis of the manufacturing process used;
- Establishment and implementation of methods for monitoring and checking such critical points;
- Taking samples for analysis in an approved laboratory by the competent authority for the purpose of checking cleaning and disinfection methods and for the purpose of checking compliance with the standards established by (the) Directive;
- Keeping a written record of the preceding points with a view to submitting them to the competent authority".

Such principles with their special reference to identification and monitoring of critical (control) points, verification procedures and record keeping are implicit references to HACCP principles (Jouve, 1994).

In 1993, the Joint FAO/WHO Codex Alimentarius Commission published guidelines for the application of the HACCP system. In the same year, the European Union published the Directive on the Hygiene of Foodstuffs 93/43/EEC and the Directive on the Additional Measures Concerning the Official Control of Foodstuffs.

In 1997, a revised edition of the General Requirements (Food Hygiene) was developed and published by the Joint FAO / WHO Codex Alimentarius Commission. This edition included the Recommended Code of Practice, the HACCP system and the Principles for the establishment and Application of Microbiological Criteria for Foods.

The HACCP approach is continuing to gain recognition and acceptance by the food industry and food-regulatory agencies (Bryan, 1999). Many of the present issues involving the HACCP system relate to specific problems of implementation, verification and validation.

International bodies and many individual countries are trying to apply this approach to all food industries. Furthermore, efforts are also made to apply the HACCP system within quality assurance systems, such as Total Quality Management (TQM) and International Standard Organisation (ISO).

2.2 Legal framework and food safety

2.2.1 Food hygiene and food laws; their origin and development

Food hygiene is defined as "all conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain" (Codex Alimentarius, 1997: 6). Food safety is "the assurance that the food will not cause harm to the consumer when it is prepared and / or eaten according to its intended use" (Codex Alimentarius, 1997: 6).

Food safety and hygiene are not new subjects. Humans have long been aware of these matters, a consequence of being affected by the consumption of contaminated food. For example, over 40,000 deaths due to ergot poisoning were recorded in France alone in A.D. 943, however it was not known that the toxin causing this disease was produced by a fungus (Jay, 1996).

Legislation relating to food was originally introduced in many countries to prevent the sale of fraudulent products and was concerned with compositional or weight defects (Hayes, 1992). From the earliest historical writings, there is evidence that governing authorities were concerned with codifying rules to protect consumers from dishonest practices in the sale of food (Codex Alimentarius, 1997). For example, Assyrian tablets described the method to be used in determining the correct weights and measures for foodgrains, and Egyptian scrolls prescribed the labelling to be applied to certain foods. In ancient Athens, beer and wines were inspected for purity and soundness, and the Romans had a well-organised state food control system to protect consumers from fraud or bad produce. Furthermore, in Europe during the Middle Ages, individual countries passed laws concerning the quality and safety of eggs, sausages, cheese, beer, wine and bread (Hobbs & Roberts, 1987).

It was not until 1837 that the great French chemist and bacteriologist, Pasteur, showed that the old theory of spontaneous generation of food damaging factors was at fault (Hobbs & Roberts, 1987). He showed that the souring of milk was caused by microorganisms. In about 1860 he used heat for the first time to destroy undesirable organisms in wine and beer (now known as pasteurisation) (Jay, 1996). He also stated that if food were sterilised by heat, living bacteria would not reappear unless introduced from the hands or other contaminated material (Jay, 1996).

In the next three sections a short review of the EU, UK, USA, Greek and Cyprus legislation are given. These countries were selected because they all influence the legal position of Cyprus in relation to food safety.

2.2.2 The development of Food Legislation in the European Community

The aim of the EU food legislation is to ensure a high standard of public health protection and that the consumer is adequately informed of the nature and, where appropriate, the origin of the product. The primary source for European Union information is the "Official Journal".

When the EU develops new piece of legislation, its Member States have to implement it.

The following areas have been covered:

- Fresh (red) meat,
- Meat products and minced meat,
- Poultry and poultry meat,
- Fish, shellfish and fishery products,
- Milk,
- Eggs,
- Water and mineral water and
- General and prospective food hygiene.

For each category many Directives have been introduced and most of them amended several times in the light of new scientific information and more modern processes and techniques. The most important of these Directives is the Council Directive 93/43/EEC on the Hygiene of Foodstuffs.

The adoption of this Directive is a landmark in the development of EU food law and formed the basis for food hygiene control across Europe. This Directive which was adopted on the 19th of June 1993, (as mentioned in Chapter 1), is one of the most powerful driving forces in Europe in the improvement of food safety.

The Directive does not use the precise wording of Codex Alimentarius or the US NACMCF. However, in article 3 it states "food business operators shall identify any step in their activities which is critical to ensuring food safety and ensure that adequate safety procedures are identified, implemented, maintained and reviewed on the basis of the following principles:

- Analysing the potential food hazards in a food business operation
- Identifying the points in those operations where food hazards may occur
- Deciding which of the points identified are critical to food safety – the "critical points"
- Identifying and implementing effective control and monitoring procedures at those critical points and
- Reviewing the analysis of food hazards, the critical control points, the control points and the control and monitoring procedures periodically and whenever the food business operations change" (Council Directive 93/43/EEC, 1993).

These principles have a number of similarities to those of Codex Alimentarius / US NACMCF with the exception of specific reference to record keeping.

Article 8 of the Directive states that "the competent authorities shall carry out controls to ensure the provisions of Article 3 are being complied with the food businesses" (Council Directive 93/43/EEC, 1993). This requirement can be interpreted as a record-keeping requirement.

Article 9 deals with the case of the failure of a business to comply with the provisions of Article 3 where this might result in risks to the safety or wholesomeness of foodstuffs. In such a case, the competent authority shall take appropriate measures which may extend to the withdrawal and/or the destruction of the foodstuff or the closure of all, or part of the undertaking for an appropriate period of time.

The Directive includes also as an annex, the Recommended International Code of Practice – General Principles of Food Hygiene of the Codex Alimentarius.

The adoption of this Directive by Member States means that all food businesses throughout EU are strongly recommended to use the HACCP approach.

2.2.3 The development of Food Legislation in the United Kingdom

The earliest food legislation in the British Isles appears to be an Act passed in England in 1266 to protect the purchaser against short weight in bread and the sale of unsound meat (HMSO, 1976). From that time, legislation has been introduced only where a need for it has been demonstrated and, when introduced, the legislation has been kept as general as is practicable (Forsythe & Hayes, 1998). More targeted legislation may has been introduced where a specific food presented a more serious hazard; such legislation generally defined the processing standards required rather than quoting microbiological standards which should be attained.

In the 1800s, analytical chemistry had been developed sufficiently to permit to the accurate and scientific identification of many ingredients in food. Based on this, the setting of a law with provisions covering quality matters was possible. This enabled the development of the 1875 Sale of Food and Drugs Act. It remained in force until 1928, when it was repealed by the consolidating Food and Drugs (Adulteration) Act (HMSO, 1976). In 1925 the use of preservatives in food was prohibited except in certain foods where their presence had to be declared on the label (HMSO, 1976). In 1938, a new law came into force combining food and drugs legislation and all the public health legislation relating to foodstuffs. This law remained into force until 1955, where the new Food and Drugs Act came into force, which again was repealed by the 1984 Food Act (Hayes, 1992).

Currently, the 1990 Food Safety Act is in force. Many codes of practices have been developed by government with advice from experts in the food industry. Their purpose is to supplement the legislation and provide guidance on the proper implementation of it. It should be noted that the codes of practice are not statutory.

For implementing particular aspects of the Directive on Hygiene of Foodstuffs (93/43/EEC), regulations have been developed. The main regulations are the Food Safety (General Food Hygiene) and (Temperature) Regulations of 1995.

On 1st April 2000 the Food Standards Agency was established and all food hygiene and safety matters were moved from the jurisdiction of the Ministry of Agriculture, Fisheries and Food (MAFF) and the Department of Health to the Food Standards Agency, which is non-ministerial government department. An independent 14-member board, accountable to Parliament through health ministers, governs the Food Standards Agency.

However, the actual work and the day-to-day enforcement of food safety is carried out by local Environmental Health Officers working in approximately 500 Local Authorities (Barnes, 2000). Exceptions to the above arrangements are the enforcement work within the fresh meat sector (e.g. slaughterhouses, cutting plants and on-farm dairy control).

2.2.4 The development of Food Legislation in the US

The earliest evidence of the presence of some kind of legislation in the US goes as far back as 1773. The New York General Assembly reacting to complaints about the poor quality of bread in New York City required that local bakers use only flour that had passed the export inspection (HMSO, 1976).

In 1890 the first national meat inspection law was enacted requiring the inspection of meats for export only. In 1895 the previous meat inspection law was amended to strengthen its provisions.

In 1906, the US Federal Food and Drug Act was passed by Congress. The introduction of the Food, Drug and Cosmetic Act led to the repeal of this law in 1938, which was the principal Federal food legislation in the United States. Through this Act the Federal Food and Drug Administration (FDA) was able to control the food industry. It covered all foods other than meat and poultry products.

The Food, Drug and Cosmetic Act of 1938 has had four subsequent major amendments: the Pesticide Chemical Amendment (1954), the Miller Food Additive

Amendment (1958), the Colour Additive Amendment (1960), and the Nutrition Labelling and Education Act (1990).

As noted before, the meats, poultry and their products were not covered by the Act of 1938 but by the Wholesome Meat Act of 1967, the Wholesome Poultry Act of 1968 and the Egg Products Inspection Act of 1970. All these Acts were under the jurisdiction of the United States Department of Agriculture (USDA).

In 1996, the Food Quality Protection Act resulted in the amendment of the Food, Drug and Cosmetic Act. In 1997, the Food and Drug Administration Modernisation Act was introduced. Among other things, this Law regulates health claims for foods. This act covers all foods other than meats and poultry and meat and poultry products. These latter foods are covered by the Federal Meat Inspection Act, the Poultry Products Inspection Act and the Eggs Products Inspection Act which are under the jurisdiction of the US Department of Agriculture). All four Acts are fairly general in content and their intentions are implemented through the Code of Federal Regulations which is revised and published annually (Forsythe & Hayes, 1998). The Code, which is subject to Federal jurisdiction, is divided into 50 "titles" which represent very general areas of interest. In addition to the Federal system of control each State also has the power to pass its own laws.

The agencies and their responsibilities regarding food safety are as follows:

(a) The US Department of Health and Human Services, which consists of:
- Food and Drug Administration (FDA) which enforces food safety laws governing domestic and imported food, except meat, poultry and processed eggs.
- Centres for Disease Control and Prevention which mainly investigate and surveil foodborne disease outbreaks and develop policies to prevent them (e.g. training),

(b) The US Department of Agriculture (USDA) through the Food Safety and Inspection Service (FSIS), which is responsible to enforce the food safety laws governing domestic and imported meat and poultry products, whether raw or processed and

(c) The US Environment Protection Agency, which is responsible for enforcing laws governing drinking water.

The Food and Drug Administration issues the "Food Code" which is a reference that guides retail outlets, such as restaurants and grocery stores, and institutions such as nursing homes, on how to prepare food to prevent foodborne diseases. This Code is revised every two years and includes updated recommendations based on the latest findings in food safety science. It covers such critical areas as raw eggs, juices, raw sprouts, ready-to-eat foods, hamburgers, pork and poultry (FDA, 1999).

The Food Code is neither federal law nor federal regulation and does not replace state or local laws. Authority to provide such guidance is granted by federal law. Thus, it is endorsed by the Food Safety and Inspection Service and the Centers for Disease Control and Prevention (FDA, 1999).

The HACCP system was introduced into the US legal system in 1996 when the Food Safety Inspection Service (FSIS) published the "Pathogen Reduction; Hazard Analysis and Critical Control Point (HACCP) Systems: the Final Rule" (Bernard, 1998). The Rule addresses the serious problem of foodborne diseases in US associated with meat and poultry products by focusing more attention on the prevention and reduction of microbial pathogens on raw products that can cause disease. Among other provisions, it requires that all meat and poultry plants should develop and implement a system of preventing controls, known as HACCP, to improve the safety of their products.

The implementation of the HACCP system by food businesses was phased in according to business size. Thus, large businesses, those with 500 or more employees, were required to have HACCP systems in place by 26th of January 1998. Small businesses, defined as having between 10 and 500 employees, were required to implement the HACCP system by 25th of January 1999. Very small businesses, defined as having less than 10 employees, were required to implement the HACCP system by 25th of January 2000.

2.2.5 The development of Food Legislation in Greece

Greece has been a Member State of European Union since 1981. Thus, all EU legislation covering food matters have been introduced in the Greek national legislative framework in order to be fully harmonised with it.

In 1999, the House of Representatives issued the Law No. 2741/1999 (28/9/1999) for the establishment of the Hellenic Food Authority. This Law covers general issues about the Authority (e.g. purpose, general competencies, relation with other authorities and structure). However, in Article 4, it is noted that the organisation of services of the Authority, their competencies and matters relating to the personnel would be determined by a Presidential Ordinance. Indeed, the Presidential Ordinance was issued and published in the Official Gazette of the Hellenic Republic in 2000 (Presidential Ordinance No. 223/2000 of 6/9/2000).

The main objectives of the Hellenic Food Authority (2003) can be translated as follows:

- "The importation, manufacturing and movement of hygienic and safe foodstuffs in order to protect the health of the consumers,
- The inspection of the quality of foodstuffs,
- The protection of the consumers' health and economic status from adulterated foodstuffs and
- The protection of the consumers from misleading information in relation to the hygiene, ingredients, labelling and price of foodstuffs."

Furthermore, the National Legislation, which adopts the Directive 93/43/EEC on the Hygiene and Official Control of Foodstuffs, is the Decision on the Hygiene of Foodstuffs in compliance with the Council Directive 93/43/EOK. This Decision (No. 487) was published in the Official Gazette of the Hellenic Republic on the 4th of October 2000.

In 2000, the Hellenic Organisation for Standardisation produced the Hellenic Standard 1416 on the Food Safety Management System – Hazard Analysis and Critical Control Point (HACCP). This Standard is based on the Standard DS

3027:1997 "Food safety according to HACCP (Hazard Analysis and Critical Control Point) – Requirements to be met by food producing companies and their subcontractors". The purpose of the Organisation is to carry out inspections / audits in food businesses based on the provisions of the above Standard and to provide the necessary accreditation.

2.2.6 The development of Food Legislation in Cyprus

The earliest Law covering food matters came into force on the 9th of June 1905 (The Food and Drugs Law of 1905). The Law was cited as the Food and Drugs Law and its scope was to make better provision with regard to the sale of foods and drugs (Official Gazette of the Republic of Cyprus, 1905). In this Law, food was defined as "every article used for food or drink by man, other than wines and spirits and other than drugs and water" (Official Gazette of the Republic of Cyprus, 1905).

Under this Law, it was an offence to produce or sell foods which were injurious to health. Furthermore, the "Peace Officers" were entitled to take samples for analysis after the purchasing of any article of food and send it to an analyst. The samples taken had to be sealed and fastened up in the presence of the seller in such manner as the nature of the food permitted.

The Food and Drugs Law of 1905 remained into force until 1938, where the new Sale of Food and Drugs Law came into force. Under this Law, the definition of food was changed to "any article used for food or drink by man, other than drugs or water, and any article which ordinarily enters into or is used in the composition or preparation of human food, and also includes flavouring matters and condiments" (The Sale of Food and Drugs Law of 1938). This Law covered many fields such as the restrictions on mixing food and drugs with other ingredients, the prohibition against sale of food and drugs not of the nature, substance or quality demanded and the labelling of the food articles. Furthermore, more powers were given to the Health Inspectors or to others appointed by the Government.

As the Sale of Food and Drugs Law did not specify the exact composition and the permitted ingredients of various articles of food, the Sale of Food and Drugs Regulations were cited in 1941. These Regulations specified the percentage of each ingredient or additive that could be added in 21 articles of food.

A new Law, the Sale of Food and Drugs Law (Amendment) came into force in 1967. The definition of food was changed to include drinks, chewing gums and all the ingredients that were used for the production of any article of food and drink, but it did not include:

(a) Water (except bottled water intended to be sold), live animals or birds,
(b) Fodder or articles used as animal, bird or fish feed and
(c) Articles or substances used only as drugs.

Under this Law, the "Scientific Food Council" was established in 1967. This Council had the responsibility of advising the Minister of Health on matters covered by this Law. Furthermore, all food establishments in which any article of food intended for human consumption was produced, manufactured or processed had to be registered at this Council, with the consent of the Health Inspector.

In 1970, the "General Food Hygiene Regulations" were introduced. These Regulations set up the registration procedure of a food establishment at the Scientific Food Council. In addition, the construction provisions (floors, walls, ceilings) and the facilities (water supply, sewage disposal) and equipment a food establishment should have, were set by these Regulations.

In 1996, the "Food (Control and Sale) Law" as amended in 2000, 2001, 2002 and 2003 repealed the "Food and Drugs Law" (The Food (Control and Sale) Law of 1996-2003). This Law is only for food and not for drugs. This Law, among other provisions, gives the power to the Public Health Inspectors to enter and inspect every food establishment and obtain all information referring to production, handling and sale of any kind of food. This Law also regulates the food sampling of foodstuffs procedure.

Under this Law, many Regulations were made in order to harmonise the National Legislation with the EU Legislation. The Hygiene and the Official Control of Foodstuffs Regulations of 2002 are the Regulations which regulates the official control of foodstuffs and adopt the EU Directives 89/397/EEC, 93/43/EEC, 93/99/EEC, 96/3/EURATOM and 98/28/EC. They entered into force on the 6th of April 2002 and repealed the 1970 Regulations. Among other provisions, Regulation 6 requires the implementation of the HACCP system by all food businesses.

2.3 WHO / FAO – Codex Alimentarius

The first International Code of Practice (General Principles of Food Hygiene) was published by the Codex Alimentarius Committee and introduced in 1969. Since then, it has had three revisions, the last of which was in 1997. The scope of the Codex Alimentarius Committee is the preparation and application of food standards and requirements the purpose of which is to protect the health of consumers and to ensure fair practices in the food trade. The Codex Alimentarius (Latin, meaning Food Law or Code) is a collection of international adopted food standards presented in a uniform manner (Codex Alimentarius, 1997). It also includes provisions of an advisory nature in the form of codes of practice, guidelines and some minor recommendations to assist in achieving the purposes of the Codex Alimentarius.

The General Requirements (Food Hygiene) of the Codex Alimentarius cover the following:

1. Recommended International Code of Practice – General Principles of Food Hygiene
2. Hazard Analysis Critical Control Point (HACCP) System and guidelines for its application
3. The Principles for the Establishment and Application of Microbiological Criteria for Foods.

All three parts should be used in conjunction with each other to ensure the production of safe and suitable food for consumption.

2.3.1 Recommended International Code of Practice – General Principles of Food Hygiene

These General Principles are recommended by WHO / FAO to Governments, food sector and consumers alike. Individual primary producers, manufacturers, processors, food service operators and retailers are included in the food sector. The objectives of these principles are:

- The identification of the essential principles (see below) of food hygiene which are applicable to each step of the food chain, from the primary production to the final consumer, ensuring therefore safe and suitable food for human consumption,
- The recommendation of a HACCP-based approach (the approach is based on the principles of the HACCP system which are analysed in the following sections of the present work), enhancing food safety,
- The indication of how to implement the above principles; and
- The provision of guidance to those sectors for which specific codes are in place.

These General Principles are divided into ten (10) sections. Each of these sections deals with a different step of the food chain. In each section, the objectives to be achieved and the rationale behind those objectives in terms of the safety and suitability of food are stated. Sections I and II cover the objectives and definitions of these principles.

These General Principles of food hygiene are essential to the successful development and implementation of a HACCP plan, as they can be used as a strong foundation (US National Advisory Committee on Microbiological Criteria for Foods, 1997). These can also be characterised as the prerequisite programmes of the HACCP system. They are not part of the formal HACCP system but they play an important role in controlling potential health hazards (Sperber *et al*, 1998).

The aspects covered by these sections are as follows (Codex Alimentarius, 1997):

- Primary production (raw materials),
- Establishment – design and facilities,

- Control of operation,
- Establishment – maintenance and sanitation,
- Establishment – personal hygiene,
- Transportation,
- Product information and consumer awareness and
- Training.

2.3.2 Hazard Analysis Critical Control Point (HACCP) System and Guidelines for its Application

The HACCP system is the second part of the General Requirements (Food Hygiene) of the Codex Alimentarius (see Chapter 2.5 for a detailed description of the system).

2.3.3 Principles for the Establishment and Application of Microbiological Criteria for Foods

These principles are intended to give guidance on the establishment and application of microbiological criteria for foods at any point in the food chain from primary production to final consumption.

The safety of food is principally assured by control at the source of raw materials, product design and process control, and the application of Good Hygiene Practices during production, processing (including labelling), handling, distribution, storage, sale, preparation and use in conjunction with the application of the HACCP system.

Microbiological criteria should be established according to these principles and based on scientific analysis and advice, and, where sufficient data available, a risk analysis appropriate to the foodstuff and its use. Microbiological criteria should be developed in a transparent fashion and meet requirements for fair trade (Codex Alimentarius, 1997). They should be reviewed periodically for relevance with respect to emergency pathogens, changing technologies and new understandings of science (Codex Alimentarius, 1997).

A microbiological criterion for food can be defined as "the acceptability of a product or a food lot, based on the absence or presence, or number of microorganisms including parasites, and / or quantity of their toxins / metabolites per unit(s) of mass, volume, area or lot" (Codex Alimentarius, 1997: 48).

Generally, microbiological analysis may be applied to define the distinction between acceptable and unacceptable raw materials, ingredients, products, lots, by regulatory authorities and/or food business operators. They may also be used to determine that processes are consistent with the General Principles of Food Hygiene (Codex Alimentarius, 1997).

2.4 Hazards in food production

A detailed and in depth knowledge of all hazards that may be present in foods and their significance to public health is of most importance in the preparation and implementation of a HACCP system (for definition of hazard see Chapter 1.1).

Hazards are divided into three categories:

- Microbiological,
- Chemical and
- Physical.

2.4.1 Microbiological hazards

Foods may contain microbiological hazards. These hazards can come from raw materials or from food-processing steps used to make the final product. Microbiological hazards are very commonly associated with humans.

Their presence in foods is often not readily recognised and,therefore,attention should be given to their prevention and if not possible, their identification and destruction. Healthy individuals are usually resistant to the consumption of foods containing moderate levels of microorganisms. However, infants, old, ill or immunocompromised individuals are more susceptible and sensitive even to very low levels of microorganisms present in consumed foods.

The microbiological hazards are categorised as follows (Dixon, 1999):

(a) Pathogenic bacteria,

(b) Parasites and protozoa and

(c) Viruses and algae.

Before giving more details for each category of microbiological hazard, it is better to analyze the factors affecting the growth of microorganisms. The environmental factors that affect the growth and multiplication of microorganisms are:

(a) Temperature and Time

Temperature is one of the most important factors that can be used to minimise the number of microorganisms that may be present in a food product. Temperature is a well-known management tool to keep bacteria levels low.

The growth of microorganisms can occur over a temperature range of less than –20 °C to over 90 °C (Harrigan & Park, 1991), but no one organism can grow over the whole range.

Microorganisms are classified with respect to their behaviour at the various temperature ranges. This classification is as follows (Sprenger, 1993):

- Psychrophiles are the microorganisms that can grow at a temperature range between –8°C and 25°C,
- Psychrotrophs between –5°C and 40°C,
- Mesophiles between 10°C and 56°C and

- Thermophiles between 35°C and 80°C.

Very low temperatures do not destroy all microorganisms, but they inhibit their growth and multiplication. On the other hand very high temperatures at the beginning affect the metabolism of microorganisms but later destroy them.

Each microorganism has different optimum for growth and lethal temperature. These temperatures are closely related to the duration of the exposure time.

Time is also important for the growth and multiplication of bacteria. The combination temperature-time can be used for the controlling of microorganisms in foods and indeed many controlling processes are based on that combination (e.g. pasteurisation and sterilisation).

(b) Nutrients

Most microorganisms are heterotrophs – they need organic material for growth. They obtain the essential basic elements from sugar, amino acids, fats and mineral. The types of food favoured by microorganisms include high protein food, whereas types of food with high sugar or salt content are unsuitable for the growth of most bacteria and are therefore potentially safe.

(c) Water Activity (a_w)

Water activity is defined as the "fraction of vapour pressure of a particular foodstuff to the vapour pressure of pure water" (Harrigan & Park, 1991: 48) and is represented by the symbol a_w. This term describes water in food, which is not bound to food molecules and is therefore available for the growth of bacteria, yeast and moulds. Water activity should not be confused with moisture content, as foods with different water activity could have the same moisture content. 0 represents bone dry and 1.0 represents pure water. Thus, moist fresh foods, such as meat or fish can have water activity as high as 0.99.

Water is essential for microbial growth. To support this growth there should be a plentiful supply of water both to serve as a component and for the transport of metabolites. When the microorganisms are found in dry environments, their growth and multiplication is prohibited. However, the spore-forming bacteria in such conditions are transformed into spores, which are more resistant to these unfavourable circumstances.

Water activity can be measured as equilibrium relative humidity (ERH), which is expressed as a fraction (i.e. produced by any food if enclosed with air in a sealed container at a constant temperature). The minimum value for microbial growth is 0.90. Yeasts are less sensitive (minimum a_w 0.88) and moulds are the least sensitive (minimum a_w 0.80). However, in all groups wide variations can be observed as there are microorganisms that react different against the reduction of a_w.
See Table 1 of Part A, Appendix C, for the water activity range.

(d) pH (Acidity-Alkalinity)

The pH (hydrogen-ion concentration) of a product is the measure of its acidity or alkalinity. The pH scale begins at zero and ends at 14. A solution with a pH of 7 is considered neutral, below 7 as acidic and above 7 as alkaline.

Microorganisms have pH range in which they can grow. There is a minimum, an optimum and a maximum pH value. For most microorganisms the optimum pH value is around 7.

In Table 1 of Part A, Appendix C, the approximate range of pH values at which the most important microorganisms grow are presented.

At pH value of 4.6 or below, disease-causing microorganisms do not grow or grow very slowly. Spoilage microorganisms, however, may grow at these low pH values and can slowly change a food's taste or appearance. So, the pH value is an important factor in controlling the growth of microorganisms and is used in all HACCP systems as a way of maintaining the safety of foods.

(e) Presence / absence of oxygen

Bacteria are categorised in relation to their ability to grow in the presence or absence of oxygen. They are divided into three categories as follows:

(a) Aerobic bacteria which must have oxygen and can grow only in the presence of air,

(b) Anaerobic bacteria which do not need the presence of air to grow and

(c) Facultative bacteria which grow either in the presence or in the absence of air.

2.4.1.1 Pathogenic bacteria

Foodborne diseases caused by pathogenic bacteria are normally categorised on the way they are caused:

(a) The infection foodborne disease where the disease resulted because microorganisms have grown on the food to produce a sufficiently large population to constitute an infective dose and

(b) The intoxication foodborne disease which is caused after the consumption of food contaminated with toxins. Toxins are produced by microorganisms grown on the food.

A characteristic that distinguishes an infection from intoxication is that the incubation period of intoxication disease is shorter as the toxins react more rapidly.

In the following table (Table 2.1) the main causative agents of infections and intoxications foodborne diseases are presented (for most important characteristics of these microorganisms, see Table 1, Part A, Appendix C and Part B, Appendix C).

Table 2.1: Infection and intoxication causing microorganisms

Infections	Intoxications
Salmonella spp.	Clostridium botulinum
Listeria monocytogenes	Staphylococcus aureus
Echerichia coli	Bacillus cereus
Shigella spp.	
Yersinia enterocolitica	
Vibrio parachaemoliticus	
Vibrio cholerae	
Aeromonas hydrophila	
Clostridium perfringens	
Campylobacter jejuni	

The reported annual number of food poisoning cases caused by the most important microorganisms for the US, UK, Greece (and Heraklion County) and Cyprus are found in tables 2.2, 2.3, 2.4 and 2.5 respectively (Centre of Communicable Diseases, 1999; Public Health Laboratory Service, 1999; National Centre for Surveillance and Intervention, 2000; Ministry of Health, 2000).

Table 2.2: Reported food poisoning cases in US (1990-1998) (Centre of Communicable Diseases, 1999)

	Salmonella spp.	Shigella spp.	E. coli 0157:H7	Botulism
1990	48603	27077	--	23
1991	48154	23548	--	27
1992	40912	23931	--	21
1993	41641	32198	--	27
1994	43323	29769	1420	50
1995	45970	32080	2139	24
1996	45471	25978	2741	25
1997	41901	23117	2555	31
1998	43694	23626	3161	116

Table 2.3: Notified food poisoning cases in UK (Public Health Laboratory Service, 1999)

Microorganism	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Salmonella spp.	30112	27693	31355	30650	30411	29314	28983	32596	23728	17251
L. monocytogenes	116	127	106	102	112	85	115	124	108	106
E. coli (O157:H7)	*	361	470	385	411	792	660	1087	890	1084
Shigella spp.	3276	10661	18069	6900	6315	4113	1849	1999	1295	1264
Vibrio cholerae	*	*	22	25	23	30	32	33	48	29
C. perfringens	1442	733	805	562	449	342	720	*	*	*
C. jejuni	*	*	38552	39422	44414	43876	43337	50177	58059	54994
S. aureus	55	61	112	28	74	59	150	*	*	*
B. cereus	*	*	8 **	2 **	7 **	8 **	4 **	*	*	*

Note: (*): There is no specific number of cases / outbreaks.

(**): The figures indicate the number of outbreaks.

The data for 1999 are provisional.

Table 2.4: Notified food poisoning cases in Greece and in Heraklion County in 1999 (National Centre for Surveillance and Intervention, 2000)

Organism	Number of food poisoning cases	
	Greece	Heraklion County
Salmonella spp.	841	18
L. monocytogenes	7	0
E. coli EPEC	75	5
E.coli VTEC	0	0
Shigella spp.	80	1
Vibrio cholerae	0	0
C. jejuni	248	7

Table 2.5: Notified cases for Salmonellosis and Staphylococcus in Cyprus (Ministry of Health, 2000)

Year	Salmonellosis	Staphylococcus
1988	31	0
1989	63	0
1990	56	0
1991	56	0
1992	97	0
1993	111	0
1994	76	0
1995	57	0
1996	52	0
1997	75	0
1998	148	11
1999	158	0

In order to reach any conclusions about the food poisoning reporting system, it is necessary to know the total population number of each country. The population of the US, the UK, Greece (and Heraklion County) and Cyprus is presented in the following table.

Table 2.6: Country population (Population Reference Bureau, 2000; Interkriti, 2002)

Country	Year	Population
US	1999	272.69100
UK	2000	59.75000
Greece	2001	10.90000
Crete	2000	540000
Heraklion County	2000	220000
Cyprus	2000	882000

From the above tables and comparing the numbers of food poisoning cases in the UK, the US and Cyprus and the population of each country, it is obvious that no efficient system exists for the reporting of food poisoning cases in Cyprus. Furthermore, the reporting system in Cyprus does not cover all the foodborne diseases, only Salmonella and Staphylococcus.

2.4.1.2 Parasites and Protozoa

Parasites are organisms that derive their sustenance on or within their hosts. A variety of parasitic animals are of concern to the food safety. They include (Rhodehamel, 1992; Forsythe & Hayes, 1998):

- Parasitic protozoa,
- Nematodes (roundworms),
- Cestodes (tapeworms), and
- Trematodes (flukes).

In Table 2.7, the relevant parasites for the food industry are presented. (Table 2, Part A, Appendix C gives the main characteristics of the principal parasitic infections of man).

Table 2.7: Parasites of major concern (Rhodehamel, 1992; Forsythe & Hayes, 1998).

Protozoa	Giardia lamblia Entamoeba histolytica Toxoplasma gondii
Nematodes (roundworms)	Ascaris lumbricoides Trichinella spiralis Anisakis spp.
Cestodes (tapeworms)	Taenia saginata Taenia solium Diphyllobothrium latum
Trematodes (flukes)	Fasciola hepatica Clonorchis sinensis

These commonly exhibit a free-living stage in soil or water and an internal parasitic stage in the gut or other tissues of man and / or other animals.

2.4.1.3 Viruses and algae

Viruses are very small particles that cannot be seen with a light microscope. They are intracellular parasites that are unable to reproduce outside the host cell. Thus, they are inert in foods and do not multiply in them (Rhodehamel, 1992). However, viruses may be transmitted to foods via the faecal-oral route, either directly or indirectly. Many different viruses have been isolated from foods of different kinds. Some viruses may be inactivated in foods by thorough cooking and some by drying. Direct contamination of foods with viruses can occur when an infected food handler contaminates food. Indirect contamination can occur when foods become contaminated in waters infected by untreated sewage (Rhodehamel, 1992).

Viruses, which infect by being ingested, are termed “intestinal viruses”. They multiply in the intestines of the infected person and large numbers of them may be excreted. Three viruses, which are important agents of human infection, are transmitted via food vectors are: small round structured viruses (SRSVs), infective hepatitis and rotaviruses.

2.4.2 Chemical hazards

Chemical is “any substance used in or obtained by a chemical process or processes” (Rhodehamel, 1992: 20). All food products are made up of chemicals, and all chemicals can be toxic at some dosage level. The effect of chemical contamination on the consumer can be long-term (chronic), or short-term (acute). Accumulative chemicals such as mercury can be carcinogenic, whereas some allergenic foods can cause short-term effects.

Chemical contamination of foodstuffs can happen at any stage of their production, from growing of the raw materials through to consumption of the finished product.

The two types of chemicals are the naturally occurring ones and the added chemicals. The main hazards of each category are presented in Table 2.8. Detailed information on these chemicals is given in Part B, Appendix C.

Table 2.8: Types of Chemical Hazards (Tzia & Tsiapouris, 1996)

Naturally occurring chemicals	Added chemicals
1. Mycotoxins • Aflatoxins 2. Scrombrotoxin • Histamine 3. Ciguatoxin 4. Mushroom toxins 5. Shellfish • Paralytic shellfish poisoning (PSP) • Diarrhoeic shellfish poisoning (DSP) • Neurotoxic shellfish poisoning (NSP) • Amnesic shellfish poisoning (ASP) 6. Pyrrolizidine alkaloids 7. Phytohemagglutinin 8. Polychlorinated biphenyls (PCBs)	1. Agricultural chemical • Pesticides, fungicides, fertilisers, insecticides, antibiotics and growth hormones 2. Prohibited substances 3. Toxin elements and compounds • Lead, zinc, arsenic, mercury and cyanide 4. Food additives 4.1 Direct • Preservatives • Flavour enhancers • Nutritional additives • Colour additives 4.2 Indirect • Plant chemicals (e.g. lubricants, cleaners, sanitisers, cleaning compounds, coating and paint)

2.4.3 Physical hazards

Physical hazards include any potentially harmful extraneous matter not normally found in food (US National Seafood HACCP Alliance, 1993). Physical hazards may be (Dixon, 1999):

- Items which are sharp and may cause injury,
- Items which are hard and may cause dental damage and
- Items of a dimension which could cause choking.

Physical hazards are the most commonly reported to be found in foods as they are very easily identified because the injury occurs immediately or soon after eating.

Physical hazards like microbiological and chemical can gain entrance to a food product at any stage of the food chain. Further, any physical hazard could transport microbiological hazards after entering the food product. This is very important in cases where the hazard enters the food after all processing steps which would control microbiological hazards have been carried out (Mortimore & Wallace, 1994).

The most common physical hazards associated with the food production, their main sources and the health effects are presented in Table 1 of Appendix C.

In addition, there are a growing number of cases of items which are perceived as physical hazards such as the presence of flies and insects in food products. Most times, their presence in the final product causes revulsion.

Raw material checking should be carried out in order to prevent physical hazards from entering the food production line and therefore the final product. Each raw material should be checked routinely for the purpose of verification of its specifications.

On the other hand, there is a number of methods for the detection and the removal of the physical hazards that have entered the food chain and the food. The main methods are listed below:

(a) Metal detectors,

(b) X-ray detection devices,

(c) Floatation tanks and centrifugal separators,

(d) Sieves and

(e) Visual inspection.

Detailed information on the methods of detection and removal of the physical hazards from the food is given in Part C, Appendix C.

2.5 Development of the HACCP system

The HACCP system is based on seven principles (Codex Alimentarius, 1997). These are:

- Principle 1: List all potential hazards associated with each step, conduct a hazard analysis and consider any measures to control identified hazards,
- Principle 2: Determine the Critical Control Points (CCPs),
- Principle 3: Establish critical limit(s) for each CCP,
- Principle 4: Establish a monitoring system for each CCP,
- Principle 5: Establish the corrective actions to be taken when monitoring indicates that a particular CCP is not under control,
- Principle 6: Establish procedures for verification to confirm that the HACCP system is working effectively and
- Principle 7: Establish documentation concerning all procedures and records to these principles and their application.

2.5.1 Prerequisite programmes of the HACCP system and Good Hygiene Practices – Good Manufacturing Practices (GHP / GMP)

Prior to initiating a HACCP plan it is necessary to develop and implement programmes to control factors that may not be directly related to manufacturing controls but which support a HACCP plan. These programmes are called prerequisite programmes and need to be effectively monitored and controlled, before implementing HACCP plans. Prerequisite programmes are, therefore, defined as "practices and conditions needed prior to and during the implementation of HACCP and which are essential for food safety" (WHO, 1999: 32).

Typically, there are eight prerequisite programmes developed by the Codex Alimentarius Commission and they are mentioned in Chapter 2.3.1.

Prerequisite programmes are essential for a successful development and implementation of a HACCP plan even though they are established and managed separately from HACCP systems. However, the existence of such programmes does not preclude the use of specific activities within a HACCP system.

2.5.2 Preparation, development and application of the HACCP system

The HACCP preparation needs the involvement of the whole organisation, from the senior management to the line supervisors, operators, incoming goods inspectors, cooks and point of sale personnel. It is easier to conduct this type of preparation, if there is a clear structure of the workforce. Senior management involvement and help in the entire process is of fundamental importance. Real commitment can only be achieved if there is complete understanding of what HACCP is, what benefits it can offer to the company and what resources will be required.

The development of the HACCP system is based on the "Logic Sequence for Application of HACCP" which has been set by the Codex Alimentarius and includes twelve (12) steps (Figure 2.1).

A detailed description of the steps 1 to 5 of the HACCP system is given in Appendix D.

Figure 2.1: Logic Sequence for Application of HACCP (Codex Alimentarius, 1997)

1.	Assemble HACCP Team	
2.	Describe product	
3.	Identify intended use	
4.	Construct flow diagram	
5.	On-site confirmation of flow diagram	
6.	List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards	(Principle 1)
7.	Determine the Critical Control Points (CCPs)	(Principle 2)
8.	Establish critical limits for each CCP	(Principle 3)
9.	Establish a monitoring system for each CCP	(Principle 4)
10.	Establish the corrective actions to be taken when monitoring indicated that a particular CCP is not under control	(Principle 5)
11.	Establish procedures for verification to confirm that the HACCP system is working effectively	(Principle 6)
12.	Establish documentation concerning all procedures and records to these principles and their application	(Principle 7)

2.5.2.1 Principle 1

Hazard analysis is a systematic evaluation of a specific food and its raw materials or ingredients to determine the risk from microbiological, chemical and physical hazards and it covers only the safety and not the quality aspects of a food). The purpose of hazard analysis is to develop a list of hazards that are of such significance that they are reasonably likely to cause injury or illness if not effectively controlled (US NACMCF, 1997). Hazard analysis is very important because if any hazard is not identified, then the HACCP system will not be effective no matter of how well it is followed.

Hazard analysis involves two stages. The first stage is the hazard identification and the second stage the hazard evaluation. As this stage is only for the analysis of hazards, no attempt should be made to identify any critical control points. For the identification of hazards the HACCP Team based on the various stages of the production line(s), develops a list of potential microbiological, chemical and physical hazards that may be introduced, increased or controlled at each step in the production process. Any historical ill-health information on the specific product under consideration will be useful when identifying the hazards associated with each process. Hazard analysis is similar to risk analysis, used extensively in environmental health. Risk analysis comprises three components (Voysey & Brown, 2000):

(a) Risk assessment which includes:
- o Hazard identification,
- o Hazard characterisation,
- o Exposure assessment and
- o Risk characterisation

(b) Risk management and

(c) Risk communication.

The HACCP system focuses solely on significant hazards that are reasonably likely to result in an unacceptable health risk to consumers. Severity is "the seriousness of the consequences of exposure to the hazard" (US NACMCF, 1997).

The estimate of likelihood of occurrence is usually based upon a combination of experience epidemiological data and information in the technical literature. The evaluation of the severity of a hazard depends on the following factors:

(a) The target market and consumer, e.g. young, old or immunocompromised individuals,

(b) The number of people likely to be affected by a hazard and

(c) The severity of the outcome (death, serious illness, mild illness, allergic reaction).

Information on the risk the various raw materials, ingredients and food possesses is of much importance in the hazard analysis process. Raw materials and ingredients are categorised as sensitive and not sensitive whereas the food products of high, medium and low risk. In Tables 2.9 and 2.10, the above categorisations are found.

Table 2.9: Sensitive and not-sensitive raw material and ingredients (Pierson & Corlett, 1992)

Sensitive	Not sensitive
Meat and poultry	Salt
Eggs	Sugar
Milk and dairy products	Chemical preservatives
Fish and shellfish	Gums and thickeners
Nuts and nut ingredients	Synthetic colours
Chocolate and cocoa	Food grade antioxidants
Mushrooms	Acidified high salt / acid condiments
Soy flour	Most fats and oils (exception is dairy butter)
Pasta	Acidic fruits
Vegetables	
Dairy cultures	

Food products are also categorised as of high, medium and low risk products. This allocation is presented in the following table (Table 2.10) and is based on the following factors:

(a) If the product is likely to contain and support the growth of microbiological hazards,

(b) If the product will undergo any additional heat processing,

(c) If future storage conditions provide opportunities for the growth of microbiological hazards or further contamination and

(d) If the population consuming the product is susceptible.

Table 2.10: High, medium and low risk food products (Dillon & Griffith, 1996)

High risk products	• Products containing fish, egg, vegetable, cereal and dairy ingredients which need to be refrigerated • Raw meat, fish and dairy products • Products with pH values of 4.6 or above that are sterilised in hermetically sealed containers or sterilised and aseptically filled into sterile hermetically sealable containers for ambient distribution • Infant formula
Medium risk	• Dried or frozen products containing fish, meat egg, vegetable or cereal and dairy ingredients • Sandwiches and meat pies for fresh consumption • Fat-based products e.g. chocolate, margarines, spreads, mayonnaise and dressings
Low risk	• Acid product with pH value below 4.6 such as pickles, fruits, fruit concentrates, fruit juices and acid beverages • Unprocessed and unpacked raw vegetables • Jams, marmalades and conserves • Sugar-based confectionery products • Edible oils and fats

As noted in Chapter 2, HACCP is a well-documented system. In this case, the results of the hazard identification and analysis (evaluation) should be documented in an appropriate form.

After the identification of the significant microbiological, chemical and physical hazards for each processing step and each ingredient, preventive / control measures should be set to avoid compromising the safety of the finished product. Control measure is "any action or activity that can be used to prevent or eliminate a food hazard or reduce it to acceptable levels" (Dixon, 1999).

When determining the preventive measures that should be established for each identified hazard, it is necessary to consider the measures that have already been in place and what new measures may need to be put in place. It should be noted that more than one preventive measure may be required to control a hazard which occurs at different stages of the process. On the other hand, more than one hazard may be controlled by one particular preventive measure.

Examples of preventive / control measures are (Dixon, 1999):

- Effective process steps (right cooking, pasteurisation and sterilisation times and temperatures),
- Use of approved suppliers,
- Controlled storage,
- Segregation of different processes within the production chain,
- Application of effective cleaning schedules,
- Application of training programmes and
- Effective pest control measures.

2.5.2.2 Principle 2

Critical Control Point (CCP) is defined as "a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level" (Codex Alimentarius, 1997: 37).

The decision tree was first developed by a Codex Alimentarius working group on HACCP in June 1991 (Canadian Food Inspection Agency, 2000). It comprises four questions (see Figure 2.2) and may be found in different forms although the same questions apply. The application of the decision tree should be flexible and requires common sense when answering the questions. It is equally applicable to the determination of CCPs for microbiological, chemical and physical hazards.

Application of the decision tree will determine whether or not a process step is a CCP for each specific, identified hazard. The complete and accurate determination of the critical control points of the operation is fundamental in controlling food safety hazards. The information developed during the hazard analysis is essential for the HACCP Team in the determination of the CCPs. The number of the CCPs is based on the specific processes followed, on the types of ingredients used in food production and the types of food produced. Thus, different businesses producing the same product may have different hazards, so the hazard analysis and the CCPs will be different.

Many inexperienced HACCP teams suffer from being overcautious. These teams have the tendency of designating too many points as CCPs that are necessary for the product(s) safety. This could lead to a complex HACCP system which will be inefficient in controlling the hazards present throughout the process. On the other hand, too few CCPs can lead to the production of unsafe food. So, it is important that control is focused where it is essential for food safety.

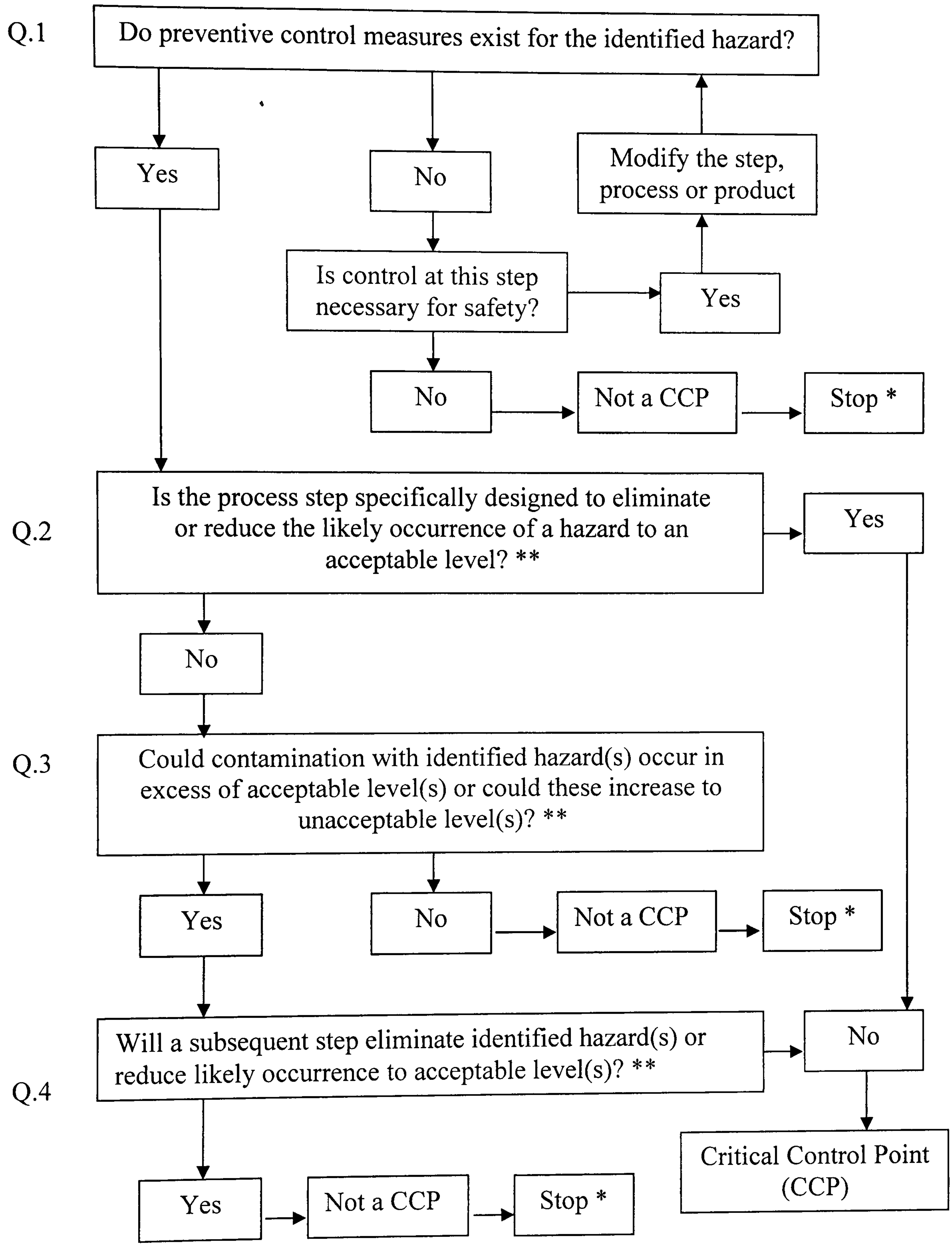
The use of a CCP decision tree promotes structured thinking and ensures a consistent approach at every process step and for each hazard identified.

Examples of CCPs include the following (Loken, 1995):

- Temperature,
- Time,
- Water Activity (a_w) and
- Acidity (pH) of the products

The decision tree answers should be documented and the team should justify its answers.

Figure 2.2: Decision tree (Adapted from Codex Alimentarius, 1997)



Note: (*) Proceed to the next identified hazard in the described process

(**) Acceptable and unacceptable levels need to be determined within the overall objectives in identifying the CCPs of the HACCP plan

2.5.2.3 Principle 3

Critical Limit is "the criterion which separates acceptability from unacceptability" (Codex Alimentarius, 1997: 34). It is a criterion which should be met for each preventive measure at a CCP. It can also be characterised as "the absolute tolerance for safety" (Mortimore & Wallace, 1994: 112). A Critical Limit is used to distinguish between safe and unsafe operating conditions at a CCP.

One CCP may have just one critical limit or there may be an upper and a lower Critical Limit. The product safety will be confirmed as long as all the CCPs are managed within their specified critical limits. Each CCP may have more than one factor which needs to be controlled to ensure food safety and each of these factors should have an associated Critical Limit. Critical Limits can be quantitative and qualitative. Quantitative may be factors such as temperature, time, physical dimensions, humidity, moisture level, water activity (a_w), pH, acidity, salt concentration, available chlorine, viscosity, preservatives, and qualitative such as colour, texture and visual appearance (shape).

Since the critical limits define the boundaries between acceptability and unacceptability of a food product, it is of fundamental importance to set the correct level for each critical limit.

Possible sources of information for this task are as follows:

- Published data which is information in scientific literature, in-house and supplier records, industry and regulatory guidelines (e.g. Codex Alimentarius, MAFF – Ministry of Agriculture, Fisheries and Food, US NACMCF),
- Expert advice – from consultants, research associations, plant and equipment manufacturers, cleaning chemical suppliers, microbiologists, toxicologists, process engineers,
- Experimental data – this is likely to support Critical Limits for microbiological hazards and may be derived from in-house experiments, specific microbiological examination of the product and its ingredients and

- Mathematical modelling – computer stimulation of the survival and growth characteristics of microbiological hazards in food systems.

As there are three different categories of hazards (microbiological, chemical, physical), it is obvious that there should be similar categories for the critical limits. However, microbiological factors can only be monitored by growing the organism of concern in the laboratory. This process may take several days, which is not practical , except in cases where non-perishable raw materials are to be controlled. There are limitations of picking up a microbiological hazard, as described in Chapter 2.1 because of the non-homogenous distribution of a microbiological hazard throughout a batch. In such cases microbiological limits are used for positive release of raw materials only if the material is homogeneous and a representative sample can be taken.

Thus, the relation between the chemical and physical parameters with the microbiological parameters should be determined. When these limits are exceeded it means that the microbiological limits are exceeded too and the product may contain or support the growth of microorganisms.

Chemical limits are used to control the chemical hazards in the product and its ingredients or the microbiological hazards throughout the product formulation. Examples of chemical limits are the maximum acceptable levels for mycotoxins, pH, salt and water activity or the absence of insecticides.

Physical limits have to do with the tolerance for physical or foreign material hazards. This tolerance may be defined as the absolute absence of physical hazards in the product. Physical limits are also used for the control of microbiological hazards, where the survival or death of microbiological hazards is governed by physical parameters (time and temperature).

2.5.2.4 Principle 4

Monitoring is one of the most important parts of the HACCP system because an unsafe product may result if a process is not properly controlled and deviation occurs.

Monitoring serves the following three purposes:

- It indicates if there is a trend toward deviation or loss of control. If there is such a case, then action should be taken to bring the process back into control before a deviation from a critical limit occurs,
- Monitoring is used to determine when there is loss of control and a deviation occurs at a CCP and to take the appropriate corrective action in such situations and
- It provides written documentation for verification purposes and to provide "due diligence" record if necessary.

There are two basic types of monitoring procedure systems, the on-line and off-line systems. On-line system means that the critical limit parameters are monitored during the process. On-line system gives an immediate indication of performance. These may be continuous systems where the data gathered from the monitoring are continuously recorded or non-continuous systems where observations are made at specified time intervals during the process. In cases of non-continuous systems, the monitoring frequency is enough in order to ensure that the CCP is under control.

Off-line system requires monitoring to be carried out away from the production line and a variable time period elapses before results are available and action can be taken. Such systems are used for salt content, pH, a_w (water activity) and total solids measurements.

As a critical limit deviation may have serious consequences, monitoring procedures should be effective. Ideally, monitoring should be on-line and continuous which is always preferred when feasible. This is possible with many types of physical and chemical methods. An example of continuous monitoring is temperature checking.

Calibration of all equipment used for the monitoring is of critical importance.

There are two ways of carrying out the monitoring, the measurement where a number indicates the compliance or not with the critical limit and the observation monitoring which is usually via a checklist.

2.5.2.5 Principle 5

Any time a critical limit is not met, corrective actions should be taken. Typically, corrective actions include:

- Determining the disposition of non-complying product,
- Determining and correcting the cause of the non-compliance to prevent a recurrence
- Demonstrating that the CCP is once again under control by examining the process or product again at that CCP and getting results that are within the critical limits and
- Maintaining records of the corrective actions that have been taken.

The corrective action(s) should correct the cause of the deviation and should control the actual or potential hazard resulting from the deviation.

The persons responsible for oversight of correction actions should have a thorough understanding of the process / product and HACCP plan.

The factors, which are often adjusted to maintain control, include temperature and time, acidity, ingredient concentrations, flow rates and sanitizer concentrations. Some examples are the following:

- Continue to cook for longer to achieve the correct centre temperature,
- Add more acid to achieve the correct pH,
- Chill rapidly to correct storage temperature and
- Add more salt to the recipe.

However, when a deviation occurs, a series of further corrective actions need to be implemented. These are:

- Place the product in question on hold,
- HACCP Team and other relevant experts involvement should be asked for
- Conduct further tests, where appropriate, to assess safety.

After the determination of the safety of the product in question the following actions would probably be taken:

- Destroy the non-complying product,
- Rework into new products,
- Release product following sampling and testing and
- Release product.

2.5.2.6 Principle 6

Verification is defined as the "application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan" (Codex Alimentarius, 1997: 35).

Verification is very important for the success of the HACCP system, it occurs on an ongoing basis and includes the following procedures (adopted from US NACMCF, 1997):

- Establishment of appropriate verification schedules,
- Review of the HACCP plan for completeness,
- Confirmation of the accuracy of the flow diagram,
- Review of the HACCP system to determine whether the facility is operating according to the HACCP plan,
- Review of CCP monitoring records,
- Review of records for deviations and corrective actions,
- Validation of critical limits to confirm that they are adequate to control significant hazards,

- Validation of HACCP plan, including on-site review,
- Review of modifications of the HACCP plan and
- Sampling and testing to verify CCPs

Verification should also be conducted when there are emerging concerns about the safety of the product or when changes in the process or of the equipment have been made.

Verification is carried out by individuals within the establishment, third party experts and by regulatory agencies. It is important the individuals responsible for carrying out the verification should have appropriate technical expertise to perform this function.

Validation is an important part of the HACCP system and the verification procedure. Validation is the process by which an establishment demonstrates that the HACCP plan is scientifically and technically sound and it actually prevents, eliminates or reduces to safe levels identified microbiological, chemical and physical hazards. The establishment is responsible for carrying out the initial validation of the HACCP plan.

2.5.2.7 Principle 7

Record keeping is very important and is an essential part of the HACCP system for the following reasons:

- It serves as written documentation for the compliance of the establishment with its HACCP plan,
- It can be used as future reference because information referring to the whole process can be found,
- It helps in identifying trends in a particular operation that could result in a deviation if not corrected and
- It is good evidence in potential legal actions against the establishment.

The list of forms used for this procedure is given in Appendix D.

2.6 The HACCP system and new / emerging hazards

In the last two decades new / emerging hazards have posed a challenge to the HACCP system. Several newly recognised foodborne pathogens have contributed greatly to the occurrence of foodborne diseases during the last two decades (Meng & Doyle, 1998). The great majority of these hazards are foodborne pathogens, but there are also chemicals of concern.

The rise of emerging hazards is due to a combination of (Mortimore & Wallace, 1994; Buchanan, 1997):

(a) Changes in microbial genotypes,
(b) Demographic changes,
(c) New technologies developed for food preparation, treatment or packaging,
(d) Globalisation of the food industry,
(e) New natural foods with less preservatives,
(f) New combinations of foods (e.g. Chilled ready-to-eat sandwiches containing unusual combinations of fish, fruit, meat),
(g) Changing legislation covering permitted additives (e.g. banning of ethylene oxide), permitted treatments (e.g. irradiation),
(h) New information on existing issues (e.g. BSE in cattle, allergens, dioxins),
(i) New ways of presenting food to the consumer (e.g. chilled ready meals) and
(j) Changes in consumer education.

Recent food scares, such as bovine spongiform encephalopathy (BSE) or the crisis related to the presence of dioxin in animal feeds that affected several countries in the European Union in 1999 showed that the food safety systems, such as HACCP, are still vulnerable in this respect (Jouve, 2000). The HACCP system cannot be expected to control unknown hazards, such as emerging foodborne pathogens (Buchanan, 1997).

2.6.1 Microorganisms

Many microorganisms previously unrecognised as foodborne or harmful are emerging as human pathogens transmitted by food (Meng & Doyle, 1997). Such microorganisms are Eschericia coli 0157:H7, Listeria monocytogenes and Salmonella enteritidis and have led to foodborne death or illness (Mayes, 2000).

The wide use of antimicrobial agents in animal feedingstuffs not only for treating and preventing animal diseases but also for promoting the more rapid growth and improving efficiency of feed conversion into meat resulted in the antimicrobials resistance of some pathogenic microorganisms (Meng & Doyle, 2002). The development of this resistance can be transferred from animals to humans through the food chain (Meng & Doyle, 2002).

2.6.2 Chemicals

Chemical hazards such as dioxins (polychlorinated chemical substances) are under consideration during the last decade as some of them are characterised as carcinogens. Dioxins have been, perhaps, the most studied of all chemicals to which humans are routinely exposed (Greene *et al*, 2003). Dioxins are formed as unwanted by-products in certain chemical processes involving chlorine and hence can contaminate the resulting products and associated wastes. They are also formed in minute amounts during combustion of fuels, incineration of waste and in other fires involving organic materials.

Food consumption is the most important route for human exposure to dioxins, contributing for more than 90% of total exposure, of which products of fish and other animal origin account for approximately 80% of the overall exposure (Commission of the European Communities, 2001). Other sources are cow's milk and milk products, bovine adipose tissue and hen's eggs (Parzefall, 2002). The highest exposure in the human population occurs in infants via breast-feeding (Parzefall, 2002).

They are extremely resistant to chemical and biochemical degradation and therefore persist in the environment and accumulate in the feed and food chain (Council Regulation (EC) No. 2375/2001 of 29 November 2001).

Dioxin and PCB monitoring programmes for food and feeding stuff in most countries of the world, including many European Countries are currently inadequate (Buchert *et al*, 2001).

It is very important to take into consideration such chemical hazards when developing and implementing the HACCP system into a food business. One of the measures that can be taken is the Suppliers Quality Assurance so as the ingredients / raw materials are from safe sources.

2.6.3 Food Allergens

Furthermore, food allergy is now considered as an important food safety issue. A food allergy is an immune response to a food or a substance, normally a protein or glycoprotein, in a food naturally, or by contamination, or produced by processing, cooking or digestion (Buttriss, 2002; Joneja, 2000). Therefore, allergic reactions to food should now be taken under consideration and the HACCP system should extend to encompass these new hazards.

A variety of foods contain ingredients that can cause adverse reactions (allergies) in hypersensitive individuals. Most adverse food reactions are caused by the following foods and their derivatives (Canadian Food Inspection Agency, 1998):

(a) Peanuts,

(b) Tree nuts (almonds, brazil nuts, cashews, hazelnuts (filberts), macadamia nuts, pecans, pine nuts, pistachios, walnuts),

(c) Sesame seeds,

(d) Milk,

(e) Eggs,

(f) Fish, crustaceans (e.g. crab, crayfish, lobster, shrimp) and shellfish (e.g. clams, mussels, oysters, scallops),
(g) Soy,
(h) Wheat and
(i) Sulphites

2.6.4 Transmissible Spongiform Encephalopathies (TSEs)

Bovine spongiform encephalopathy is one of a whole family of diseases called transmissible spongiform encephalopathies (TSEs). Bovine spongiform encephalopathy has a long incubation period (four to six years for cattle infected with BSE to show signs of the disease, such as disorientation, clumsiness and, occasionally, aggressive behaviour towards other animals and humans).

A number of basic measures for the protection of public health from the potential risk of acquiring BSE have been issued by the World Health Organisation as well as by national and regional governments and organisations (European Union) (Fishbein, 1998). However, these were designed to reduce the risk, not to eliminate it entirely (Krebs, 2001).

The results of a study carried out in UK in 1998 to investigate the public concerns about different food hazards showed that risk communication about BSE would need to deal with the effects on human health as a result of beef and beef product consumption (Miles & Frewer, 2001).

2.7 The HACCP system and quality

Quality as defined in ISO 9000 is “the totality of features or characteristics of a product or service that bear on its ability to satisfy a given need” (Tricker, 1997).

Quality of a product can be better achieved through a quality management system. A quality management system as defined in the ISO 9000 is "an organizational structure of responsibilities, activities, resources and events that together provide procedures and methods of implementation to ensure the capability of an organization to meet quality requirements".

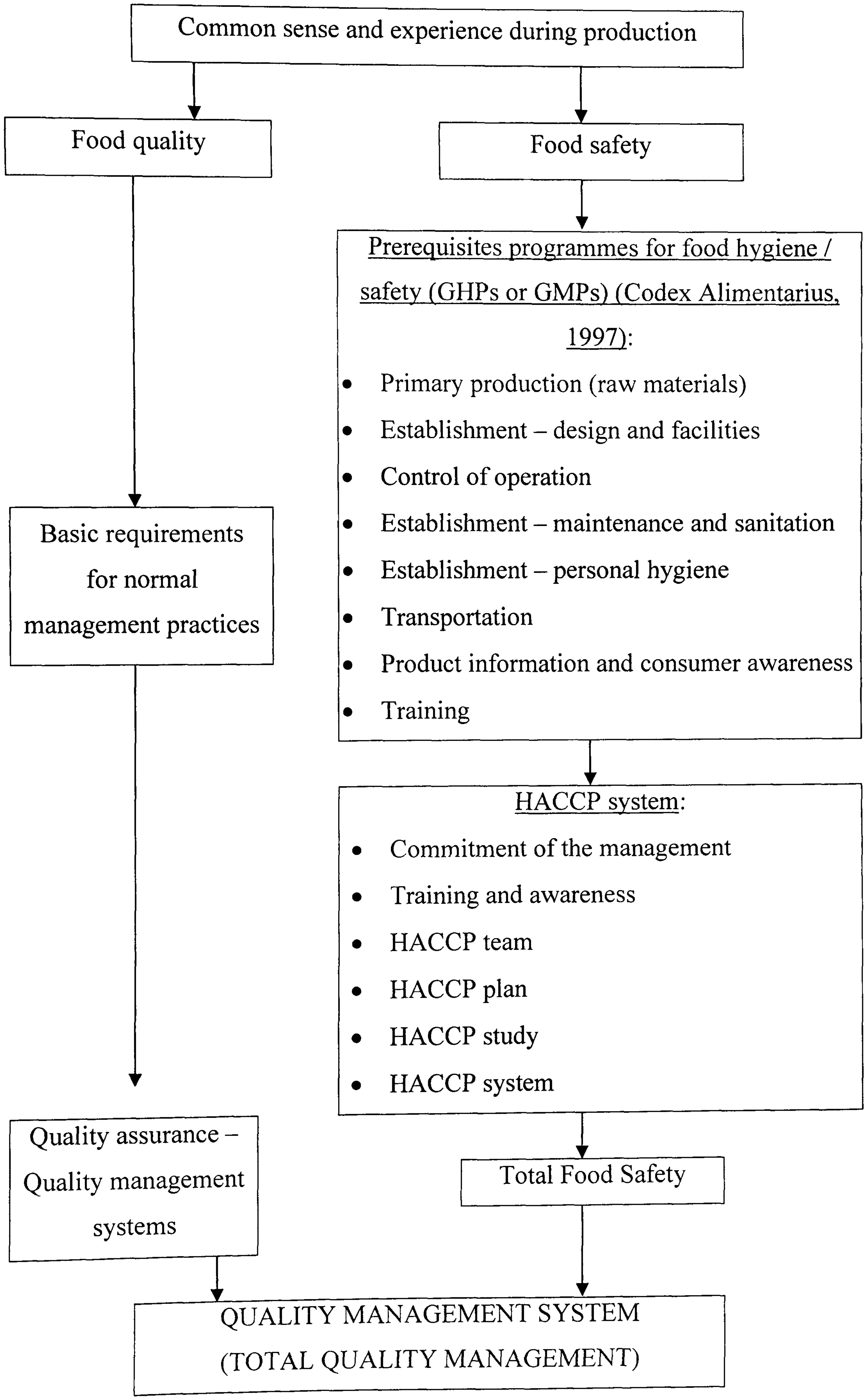
Food safety is a fundamental component of food quality and therefore of a quality management system. The HACCP system is part of such systems because it helps to the meet the food safety specifications set during the development of the HACCP system, thus ensuring the production of safe food.

The development of an overall quality management system including a quality standard and the HACCP system will ensure the continuous production of safe food which will also satisfy customer' s quality expectations (Macdonald & Engel, 2001) (see Figure 2.3). In other words, the HACCP system will ensure the safety of the product and the quality system will ensure that this level is constantly met.

On the other hand, having in place a quality system without a HACCP system there is the possibility of the consistent production of an unsafe product in the case where the specifications set do not quarantine the safety of the product.

Any food businesses having a quality management system in place can better maintain the HACCP system as many requirements of quality are used in the HACCP system. Such requirements are the calibration of the equipment, training of employees, controlled documentation and verification of the system.

Figure 2.3: An integrated approach of food safety and quality



The benefits that were observed from food businesses implemented a total quality management are as follows (Rose, 2001):

- Economic due to reduction in the amount of wasted materials, in the number of customer complaints and prevent possible food poisoning cases to occur with all consequences,
- Marketing due to customers satisfaction and therefore customers are more confident in the consistency of a product and they see a commitment to quality,
- Internal as the staff of the business improves its knowledge on quality and increases the commitment to quality and as a result there is a uniform approach to procedures carried out in the business and
- Fulfilling legislative requirements as the quality system provides documented evidence of its functioning through written procedures, of its success through records and of its ability to improve through audits and reviews.

2.7.1 The HACCP system and ISO standards

ISO is the acronym for International Organisation of Standardisation and is headquartered in Geneva, Switzerland. ISO 9000 series quality management standards can be used in conjunction with the HACCP system. It comprises five individual, but related, international standards on quality management and quality assurance. The ISO 9000 series focuses on documenting the quality system elements, improvement plans and procedures to maintain and improve an organisation's process, with particular emphasis on quality. Although ISO 9000 series was designed primarily for manufacturing organisations, it has been applied to all types and sizes of organisations (Sparling *et al*, 2001). ISO 9000 series aims primarily at preventing and detecting any non-conforming product during production and distribution to the customer, and by taking the corrective action to ensure that the non-conformance does not occur again (Mortimore & Wallace, 1994). It contains the concept of prevention of nonconformity in design and production than depending on final inspection. Furthermore, it offers the additional facility in that the systems and procedures making up the system are formally recorded so that they can be assessed externally and accreditation / certification given meets the requirements of the standards (Khandke, 2000).

An equivalent standard to the ISO 9000 series is the EN 29000 which is the European Standard (European Committee for Standardization). Furthermore Article 6 of the European Directive 93/43/EEC refers that “Member States shall, if they consider it appropriate, recommend food business operators to apply the European Standards of the EN 29000 series in order to implement the general rules of hygiene and the guides to good hygiene practice”.

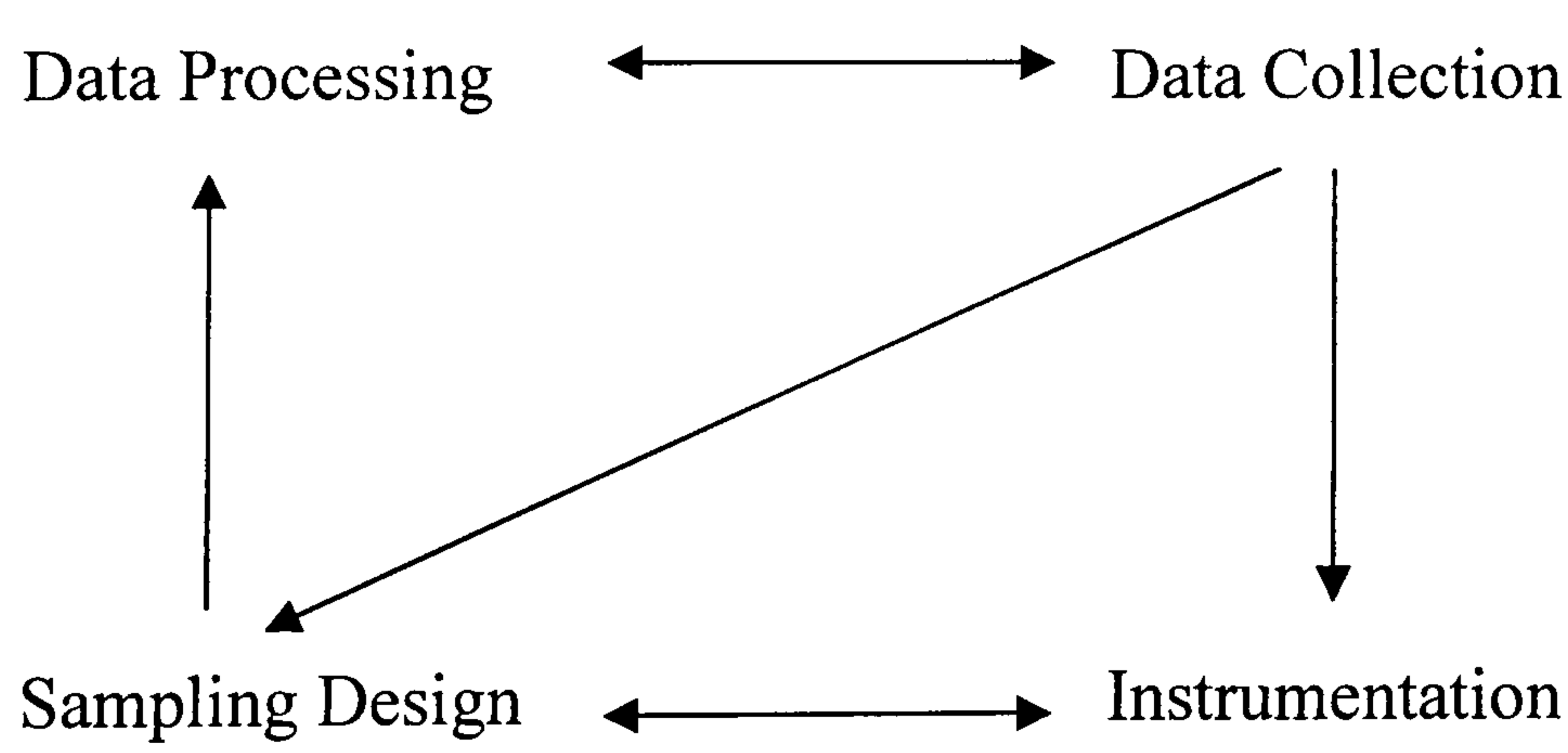
3 METHODOLOGY

3.1 General

3.1.1 Research planning

Every research is a process with many stages. Alreck and Settle (1995) identified this process in the following figure (Figure 1.1). The planning stage is very important as it provides the framework for the work. The conduct of a research is heavily influenced by the availability of resources and, particularly, by the financial burden of the data collection. Most of the time , the data collection appears to be the most expensive stage in the process and therefore, it is necessary to consider its implications for the research. Practicalities of data collection will influence possible modifications of the sampling design, instrumentation and data processing procedure.

Figure 1.1 Schematic Nature of Research Planning (adapted from Alreck & Settle, 1995)



3.1.2 Literature search

The literature search for this work involved reviewing all readily available materials on the subject. These materials include both the published and unpublished literature. Government publications, both in Cyprus and Greece were also considered.

Published literature includes articles in the scientific journals, books and reports. These can be found on the World Wide Web (online databases) or in libraries as hard copies. The author of this work has used the following online databases:

(a) Biomed,

(b) Pubmed,

(c) Science Direct,

(d) Medline,

(e) CSA Databases,

(f) Biology Digest,

(g) BIDS,

(h) Toxline and

(i) Biological Sciences.

The "grey literature" search covered:

(a) The lecture notes of seminars given on the subject and attended by the author (see Part A, Appendix E),

(b) The manuals and other literature the author obtained through his practical / field work and through the conduct of the Cyprus survey and Crete study (see Appendix E) and

(c) Other unpublished work.

The literature search revealed that there was little information on the HACCP system in relation to Cyprus.

3.1.3 Data collection

The data collection stage is the most crucial step, which guides the following steps of the research. Thus, following the literature review, different methodologies were considered for the purpose of this research. Advantages and disadvantages of the various data collection methods were evaluated. The combination of questionnaires and interviews for the data collection were selected as the most appropriate.

The questionnaire has been designed according to the principles and directions available in the literature (Bowling, 1997; Alreck & Settle, 1995; Oppenheim, 1992; Bell, 1999). The author of this work examined three questionnaire-based surveys (postal surveys) and one interview-based survey on the HACCP system and food safety. Two of these surveys were large in size and the other two were relatively small. Questionnaires were tested first in a pilot study and then, after modifications administered to 300 food businesses in Cyprus.

The respondents filled in the questionnaire with the author not being present to avoid the interviewer bias. Personal interviews were conducted only for verification purposes and for collecting extra information. In cases where the respondents faced difficulties in completing the questionnaire, additional guidance was given to them by the author.

Questionnaires were also used by other researchers in the same field, for example Ehiri *et al* (1997a), Gunningham (1993) and Panisello *et al* (1999). The questionnaire method is considered reliable and efficient for large surveys and as the author was visiting each selected business, the response rate was almost 100%. This resulted in the minimisation of the data collection costs. In addition, personal interviewing provided the most complete contact with respondents because face-to-face interaction permits both audible and visual communication with respondents (Alreck & Settle, 1995) and a consistent author-respondents communication.

3.1.4 Maintaining Professional Ethics

Individuals participating in surveys should not be put at a disadvantage and should appreciate the value of these investigations (Bowling, 1997). Thus, ethics and ethical problems were taken into consideration when conducting this research. For that reason, the author decided that the respondents' anonymity should be maintained and respected. All respondents were made aware of this before starting completing the questionnaire. Furthermore, they were informed that they were free to withdraw at any time and also that the author will provide any information about the research in general and the contents of the questionnaire in particular. This voluntary consent safeguarded the freedom of the respondents, which gave the opportunity to express themselves freely.

3.1.5 Data processing

As the completed questionnaires and other data relating to each questionnaire were collected, a serial number was given to each questionnaire for coding purposes. Computer software was used to enter all the results of the questionnaires of the Cyprus survey and the Crete study to produce the data files.

In order to enter the answers of the completed questionnaires, the analysis programmes were prepared. The possible answers of each question included in the questionnaire were coded, so as to be easily entered into the programme and analysed.

The results of the main study were analysed using the Statistical Package for the Social Sciences (SPSS) versions 9 and 10 (SPSS Inc., 1998 and 2000). This statistical computer programme was used to analyse the results of other similar surveys conducted by Ehiri *et al* (1997a, 1997b).

For the analysis of the data entered on to the computer software, a frequency and percentage distributions of response (frequency tables) and cross-tabulations were used to obtain additional information and relationships contained in the data. The percentage distributions are, however, more easily understood, of more interest and easily interpreted (Alreck & Settle, 1995). The cross-tabulation is a common measure of association between survey variables the results of which are also easily understood and interpreted (Alreck & Settle, 1995).

3.2 Cyprus survey

The Cyprus survey comprised the following stages:

1) Design of the questionnaire for the pilot study,
2) Conduct of the pilot study,
3) Analysis of the results of the pilot study,
4) Design of the questionnaire of the main survey,
5) Conduct of the main survey,
6) Analysis and discussion of the results of the main survey.

The total number of food businesses in Cyprus in 1999 was 4330, information on these is presented in Part A of Appendix A (Statistical Service of the Republic of Cyprus, 2000a; Ministry of Health, 2000a). For the purpose of this research they are divided into three categories:

- Food processing and manufacturing,
- Catering businesses and
- Hotels with restaurants and B/B accommodation.

The first group of businesses were further divided into 16 subcategories.

3.2.1 Design of the questionnaire of the pilot survey

The main objective of the pilot study was to test whether the questions were easily understood and to identify any possible modifications that would improve the effectiveness of the questionnaire. In constructing the questionnaire, experience of other researches were taken into consideration (Mortlock *et al*, 1999; Panisello *et al*, 1999; Gunningham, 1993; Ehiri *et al*, 1997a and 1997b).

The questionnaire of the pilot survey included 35 questions arranged in 5 parts (see Part A, Appendix B). The first part comprised 7 questions and was designed to obtain general information about the respondent and the business. The second part comprised 10 questions and was designed to obtain information on practices followed in the business. Part three comprised 12 questions and was designed to identify whether the business employed the HACCP or any other food safety control system. The fourth part comprised 2 questions and was designed to find out the reasons why HACCP was not applied, and whether there were plans to introduce the system. The last part included 4 questions and aimed to assess the accessibility to information on HACCP and the role of Public Health Inspectors.

3.2.2 Design of the questionnaire of the main survey

Following an in-depth analysis of the answers to the pilot study, the main questionnaire for the Cyprus survey was constructed. It was decided that the structure of the main questionnaire should remain intact, however 15 questions were dropped, one new question was added and the remaining questions were modified accordingly. The questions, which were not included in the final version of the questionnaire, were designed to assess the HACCP auditing and were deemed too detailed. The questions on gender of the respondents and their total duration of employment in the food sector were dropped to keep the size of the questionnaire under control and because these questions did not yield much information.

The questions of the main questionnaire were arranged in 4 parts. The first part comprised 4 questions and was designed to obtain general information about the respondent and the business. The second part comprised 8 questions and was designed to obtain information on the knowledge of the respondents on food safety and practices followed in the businesses. The third part comprised 7 questions and was designed to obtain information on whether the HACCP system was applied in the businesses. The last part comprised 2 questions and its purpose was to identify the reasons for not having the HACCP system in place, and the businesses' future plans. Respondents who claimed that implementation of the HACCP system would cost too much money were asked to give their estimate of the costs involved. In cases where there has been a recent decision to implement the system, the time scale of implementation was asked.

Businesses in the pilot study were excluded from the main survey.

The total number of selected businesses gave a statistically representative sample of the actual food hygiene standards in Cyprus. The method of selecting the sample is described in Chapter 3.2.3. Food industry and hotels represent 11.2% and 11.4% respectively, whereas catering businesses 5% of the total number of each kind of business. Because of the large number of restaurants and taverns, a total number of 100 establishments were visited.

3.2.3 Getting a representative sample

The sample for the pilot study comprised 40 businesses so as to create a realistic impression of the possible improvements that could be necessary for the main survey.

The method used for selecting a representative sample for the main survey was based on:

- A fixed percentage of the businesses of each category compared to the total number of the businesses and
- The food safety risks involved in the processes for the specific types of business.

The main survey covered a total number of 300 businesses, which represented 6.9% of the food businesses in Cyprus. The number of businesses of each category that was visited (see Part A of Appendix A) was decided based on the following:

- Where the total number of businesses was five or less, all were visited
- For numbers between 6 and 10, five of those were visited,
- For numbers greater than 10 but less than 70, a minimum of 5 and maximum of 9 were visited,
- For numbers greater than 71, the selection was based on the percentage of these businesses to the total number of businesses and
- Because of the large number of restaurants and taverns, a total number of 135 businesses were visited. This was considered to be adequate from the statistical viewpoint.

The questionnaires of the pilot study and the main survey were prepared in English and translated into Greek so as to make it easier for the Greek-speaking respondents.

3.2.4 Additional information on data collection

A first questionnaire (see Part A, Appendix B) was designed and used for pilot study between April and June of 2000.

Based on the findings of the pilot study, the main questionnaire was designed. The author visited all 300 selected businesses and provided further information to the respondents in relation to the contents of the questionnaire. All questionnaires were filled in by respondents and collected between August 2000 and March 2001. The questionnaire was completed by one person in each business (preferably the owner). To assist with the completion of the questionnaires, the author requested the assistance of the Public Health Services of the Ministry of Health in Cyprus. The Head of the Public Health Services agreed that the District Public Health Inspectors would provide help to the author when visiting the selected businesses. This was expected to promote a better rapport between the owner/employee and the researcher.

3.3 Crete study

The Crete study comprised the following parts:

1) Construction of the questionnaire of the survey,
2) Conduct of the survey and
3) Analysis and discussion of the results of the survey.

However, some minor changes of the questionnaire used for the Cyprus survey were made in order to be used for the Crete study.

3.3.1 Design of the questionnaire of the Crete study

The questionnaire used to carry out the Crete study differed from the one used for the Cyprus survey in the following questions:

(a) Question 17, the answer "Due to impending legal requirement" was changed into "Due to legal requirement",

(b) Question 20, the answer "There is no legal requirement of implementing HACCP" was removed and

(c) Question 21, the answer "Not at all unless it is a legal requirement" was also removed.

The reason for having the above changes been made is that the HACCP system was legally mandatory in Greece at the time of the survey conduction. The HACCP system became mandatory since 4th October 2000 (Official Gazette of the Hellenic Republic, 2000).

In preparation of this questionnaire, the author had extensive consultations with the members of staff of the Laboratory of Clinical Bacteriology, Parasitology, Zoonoses and Geographical Medicine, Unit of Food, Water and Environmental Microbiology, Medical School, University of Crete, Greece. The questionnaire was modified between July and September of 2001 (see Part C, Appendix B).

The survey in Crete was carried out in December 2001. This was done in collaboration with the members of staff of the Laboratory of Clinical Bacteriology, Parasitology, Zoonoses and Geographical Medicine, Unit of Food, Water and Environmental Microbiology, Medical School, University of Crete. This Laboratory is involved in the HACCP systems developing, monitoring and auditing in Crete, Greece and generally in Eastern Mediterranean. It is a WHO collaborative centre and has a wealth of information on the subject.

Previous surveys in UK and Ireland worked on the basis of 3% or less returns as adequate basis for comparison (Mortlock *et al*, 1999; Panisello *et al*; Food Safety Authority of Ireland, 2001). (For specific number of food businesses, see Appendix A, PartB).

In view of the lack of time and resources, this percentage was deemed suitable for the study in Crete.

4 CYPRUS SURVEY: RESULTS AND DISCUSSION

4.1 Results of the Cyprus survey

As stated in Chapter 1.2, the aims of this survey were to

(a) Determine the hygiene status of the food businesses,

(b) Identify the respondents level of knowledge about food safety / hygiene and the HACCP system,

(c) Identify the level of implementation of the HACCP system,

(d) Identify the training needs of food handlers,

(e) Suggest measures in order to:

- Improve the knowledge of food handlers about food safety / hygiene and the HACCP system and
- Promote wider implementation of HACCP in all food businesses and especially of the small and medium sized food businesses.

The survey covered a total number of 300 food businesses, which represented the 6.9% of the total number of food businesses in Cyprus. They are divided into 3 categories: industry, catering businesses and hotels with restaurants and Bed and Breakfast (B/B) accommodation. The industry businesses were further divided into 16 categories based on the kind of food handled / produced. Catering businesses included restaurants, taverns, pizzas and take aways.

4.1.1 Age of respondents and position in the business

Two-thirds (66.4%) of the respondents were between 30-49 years old. The distribution of respondents' ages in the specified age categories is found in Table 4.1.

Table 4.1: Distribution of respondents' ages

	Frequency	%
20-29 years old	43	14.3
30-39 years old	101	33.7
40-49 years old	98	32.7
50-59 years old	49	16.3
More than 60 years old	9	3

The questionnaire was intended to be filled in by the owners of the businesses (see Chapter 3). However, in reality it was impossible to do this and other members of staff completed the questionnaire. Thus, obviously the respondents had to specify their position in the business. In the following table (Table 4.2), the frequencies and the percentages of the respondents' position in the businesses are found. Two hundreds and forty-five (81.7%) of the respondents were the owners and managers of the businesses.

Table 4.2: Respondents' position in the business

Position in the business	Frequency			
	Hotel (%)	Catering business (%)	Industry (%)	Total (%)
Owner	4 (8.2)	63 (46.7)	68 (58.6)	135 (45)
Manager	23 (46.9)	54 (40)	33 (28.4)	110 (36.7)
Chef	11 (22.4)	14 (10.4)	1 (0.9)	26 (8.7)
Production Line Supervisor	3 (6.1)	3 (2.2)	11 (9.5)	17 (5.7)
Food Technologist	0 (0)	0 (0)	1 (0.9)	1 (0.3)
Food and Beverage Manager	7 (14.3)	1 (0.7)	0 (0)	8 (2.7)
Quality Control Supervisor	1 (2)	0 (0)	2 (1.7)	3 (1)

4.1.2 Level of education of respondents, kind of food business and years of operation

Almost half of the respondents (48.7%) had not acquired a College or a University degree (i.e. Diploma, Bachelors or Master). In Table 4.3, the respondents' level of education is presented.

Table 4.3: Level of education of respondents

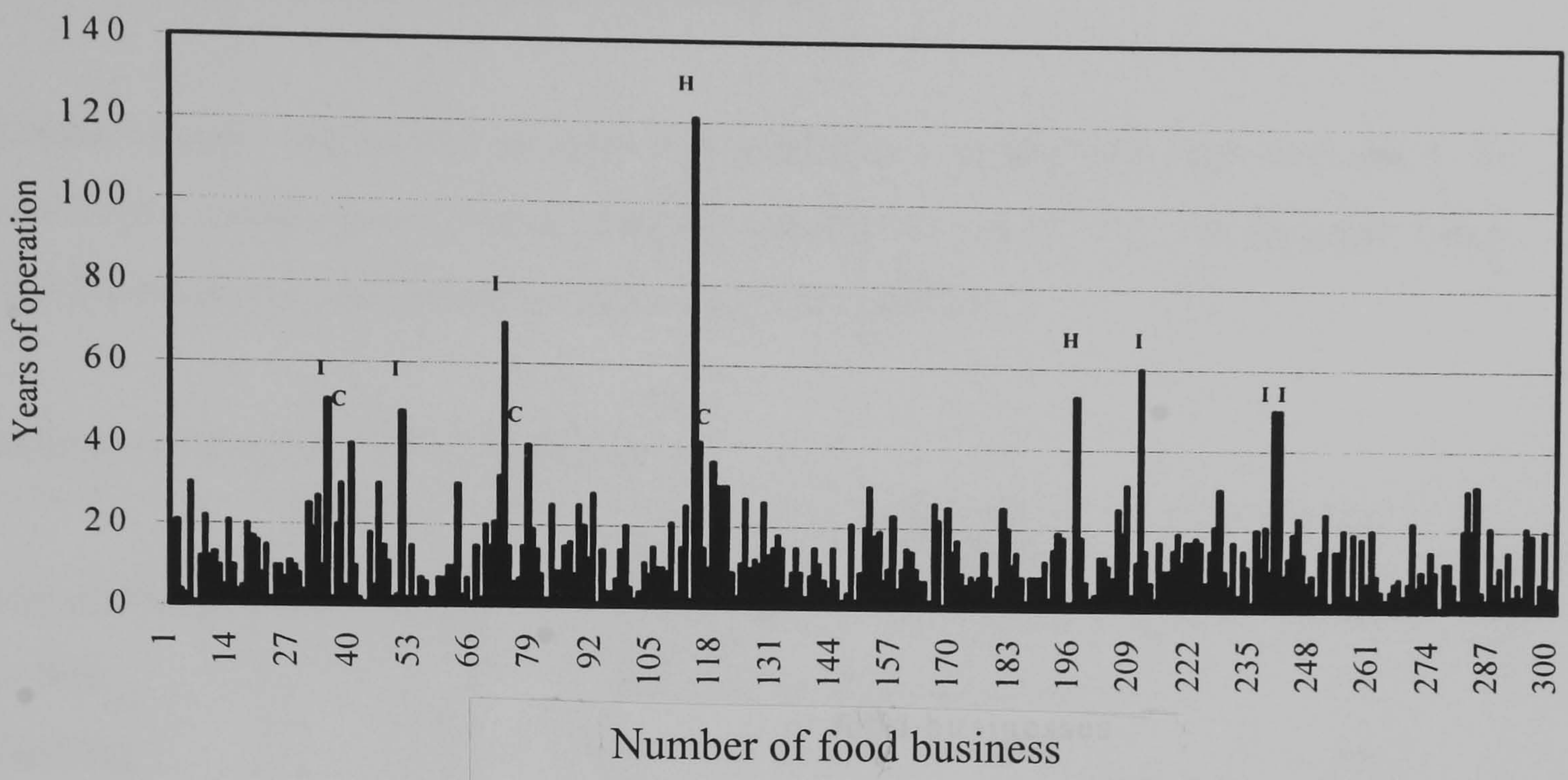
	Frequency	%
Primary school certificate	22	7.3
High school leaving certificate	5	1.7
Lyceum leaving certificate	119	39.7
Total number of respondents without College or University degree	146	48.7
Diploma	82	27.3
BSc/BA	59	19.7
MSc/MA/MBA	13	4.3
Total number of respondents with College and University degree	154	51.3

The mean numbers of years of operation of each category of food business were 16.5, 11.1 and 15.2 years for hotels, catering and industries respectively. If however, the oldest business from each category (121 years for hotels, 41 for catering and 70 for industries) is excluded then, the mean numbers drop down to 14.3, 10.8 and 14.6 years for hotels, catering and industries respectively. In Table 4.4, the mean numbers of years of operation of each category of food businesses are presented. In Chart 4.1, the years of operation for each food business are presented.

Table 4.4: Mean numbers of years of operation of each category of food business.

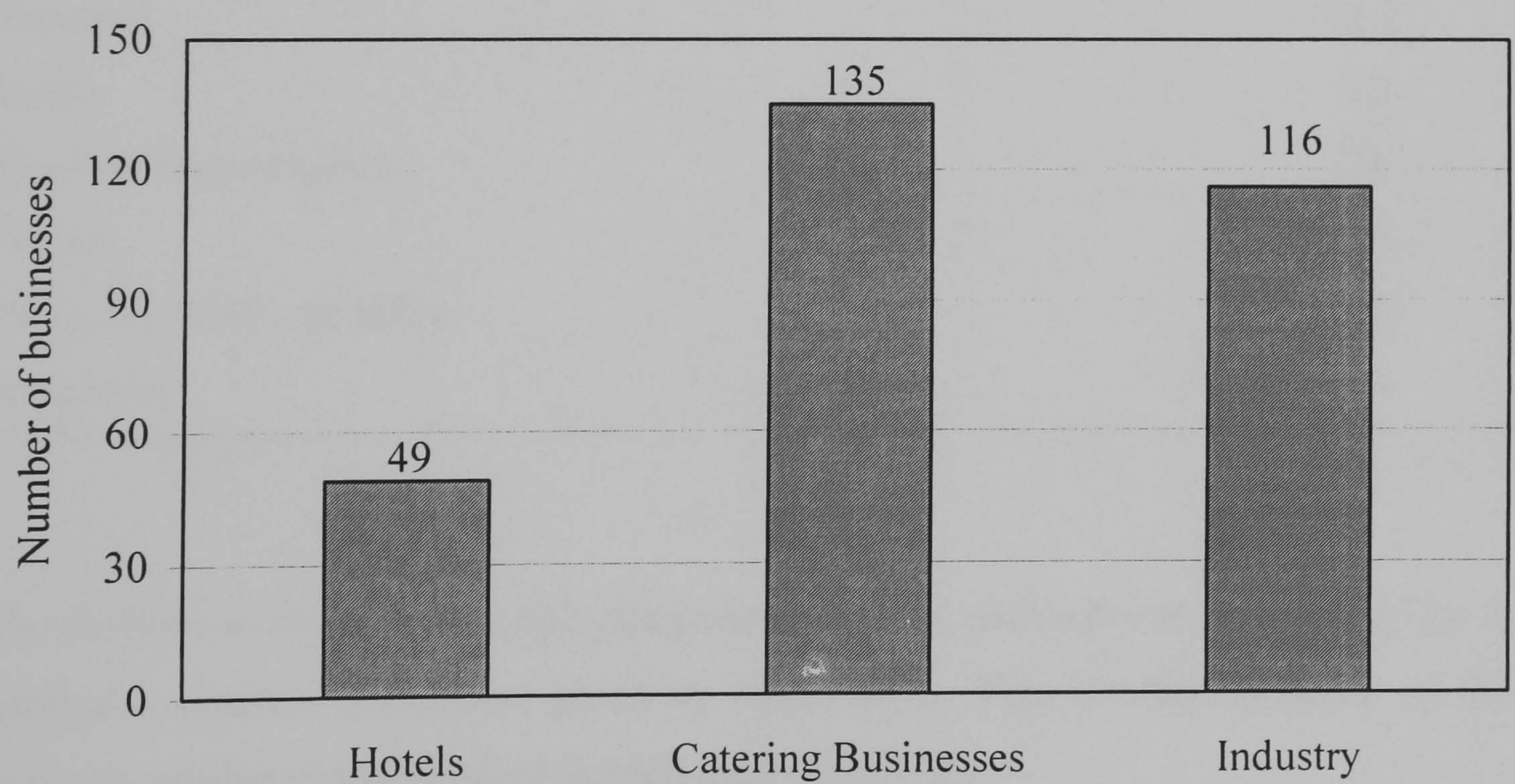
Kind of business	Mean number of years of operation
Hotel	16.5 (14.3)
Catering	11.1 (10.8)
Industry	15.2 (14.6)

Chart 4.1: Years of operation of food businesses



Forty-nine (16.3%) of the surveyed businesses were hotels, 135 (45%) were catering and the remaining 116 (38.7%) were industries. These results are presented in Chart 4.2.

Chart 4.2: Number of surveyed businesses of each category



This question was addressed only to the respondents from the industry. As noted before, the total number of industries was 116 and they were divided into 16 categories as presented in Table 4.5.

"Various" means the industry which produces a variety of products and therefore cannot be included in any of the listed categories.

"Confectionery" means the industry that produces a variety of sweets and cakes. In some cases, confectioneries may produce baked products as well. On the other hand, a bakery produces only baked products including pastries.

Table 4.5: Categories of food industry

	Frequency	%
Soft drinks, juices and syrups	5	4.3
Coffee	2	1.7
Canning	1	0.9
Pasta	5	4.3
Alcohol and spirit	5	4.3
Catering	2	1.7
Various	19	16.4
Confectionery	21	18.1
Flour mill	2	1.7
Meat products	8	6.9
Bakeries	25	21.5
Dairy	5	4.3
Seed oil and margarine	3	2.6
Water	5	4.3
Dry nuts, tahini and halva	2	1.7
Ice cream	6	5.2

The division of industry into risk categories (i.e. high, medium and low-risk) helps to analyse a number of answers given by respondents. This division is based on the products produced and handled in each kind of industry.

The following parameters are taken into consideration for the industries characterisation as high, medium or low-risk:

- If the product is likely to contain and support the growth of microbiological hazards,
- If the product will undergo any additional heat processing,
- If future storage conditions provide opportunities for the growth of microbiological hazards or further contamination and
- If the population consuming the product is susceptible.

"High-risk" are the areas of food industry in which sensitive raw materials and ingredients are used. "Sensitive raw materials and ingredients" are defined as the "raw materials and ingredients that are historically associated with known microbiological and, chemical and physical hazards" (Pierson and Corlett, 1992: 30-34). On the basis of this approach, the surveyed industries were divided into high, medium and low-risk industries. This division is set out in Table 4.6.

Hotels and catering businesses are characterised as of high-risk because all of them handle and serve sensitive raw materials (meat, poultry etc) and ingredients.

Table 4.6: High, medium and low-risk areas of food industry

High-risk	Medium-risk	Low-risk
Meat	Pasta	Flour mill
Ice cream	Seed-oil and margarine	Coffee
Dairies	Water bottling	Alcohol and spirit
Confectioneries		
Dry nuts, tahini and halva		
Various		
Bakeries		
Catering		
Soft drinks, juices and syrups		
Canning		

The hazards (microbiological, chemical and physical) are not always the same for the three risk categories. In Table 4.7, the possible implicated hazards in each type of industry from the listed hazards are presented.

Table 4.7: Possible implicated hazards in each type of industry

High-risk	Possible
Meat Catering Various	Salmonella Staphylococcus C. jejuni E.coli Food additives Veterinary residues Physical
Ice cream Dairies Confectioneries	Salmonella Staphylococcus C. jejuni E. coli Spoilage organisms Food additives Veterinary residues Physical
Dry nuts, tahini and halva Bakeries	Spoilage organisms Mycotoxins Agricultural chemicals Physical
Soft drinks, juices and syrups	E. coli Spoilage organisms Food additives Physical
Canning	Clostridium botulinum Agricultural chemicals Veterinary residues Physical

…/ continued

Medium-risk	Possible hazards
Pasta	Spoilage organisms Mycotoxins Physical
Seed-oil and margarine	Spoilage organisms Agricultural chemicals Physical
Water bottling	E. coli Agricultural chemicals
Low-risk	Possible hazards
Flour mill	Spoilage organisms Mycotoxins Physical
Coffee	Spoilage organisms Mycotoxins
Alcohol and spirit	Spoilage organisms Mycotoxins Physical

4.1.3 Cross-tabulations

(d) Age of respondents and their position in the business

In the following table (Table 4.8), the cross-tabulation between the age of the respondents and their position in the business is found. In Table 4.9, the distribution of respondents within the three kinds of businesses is presented. "H" means hotels, "C" catering businesses and "I" industries. The purpose of these cross-tabulations is to identify if there are any differences of the age ranges of employees among the specified positions. Between the ages of 20-39, the owners of the businesses were less than the managers whereas between the ages of 40-59, they were more.

Table 4.8: Cross-tabulation of the respondents' position in the business and their age

Position in the business	Age				
	20-29 years old	30-39 years old	40-49 years old	50-59 years old	More than 60 years old
Owner	15	33	49	32	6
Manager	17	42	39	10	2
Chef	4	14	5	3	0
Production line supervisor	2	7	4	3	1
Food technologist	1	0	0	0	0
Food and Beverage Manager	4	3	0	1	0
Quality control supervisor	0	2	1	0	0

Table 4.9: Cross-tabulation of the respondents' position in the business and their age according to the three kinds of businesses

Position in the business	Age														
	20-29 years old			30-39 years old			40-49 years old			50-59 years old			More than 60 years old		
	H	C	I	H	C	I	H	C	I	H	C	I	H	C	I
Owner	0	10	5	0	13	20	2	19	28	2	16	14	0	5	1
Manager	2	13	2	13	19	10	8	16	15	0	4	6	0	2	0
Chef	3	1	0	7	6	1	1	4	0	0	3	0	0	0	0
Production line supervisor	0	0	2	1	3	3	1	0	3	0	0	3	1	0	0
Food technologist	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Food and Beverage Manager	4	0	0	3	0	0	0	0	0	0	1	0	0	0	0
Quality control supervisor	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0

(e) Age of respondents and kind of food business

Most respondents from hotels and catering businesses were between 30-39 years old, whereas from the industry sector between 40-49 years old.

In the following table (Table 4.10), all the results are found with the percentages of each age group.

Table 4.10: Cross-tabulation of the respondents' age and the kind of the food business

Age	Kind of business					
	Hotel	(%)	Catering	(%)	Industry	(%)
20-29 years old	9	(18.4)	24	(17.8)	10	(8.6)
30-39 years old	25	(51)	41	(30.4)	35	(30.2)
40-49 years old	12	(24.5)	39	(28.9)	47	(40.5)
50-59 years old	2	(4.1)	24	(17.8)	23	(19.8)
More than 60 years old	1	(2)	7	(5.2)	1	(0.9)

(f) Age of respondents and their level of education

The respondents of ages between 20-29 and 30-39 years old were more qualified as 31 (72.1%) of the first age group and 59 (58.4%) of the second, had acquired a Diploma or a University Degree. However, respondents older than 40 years old were less qualified. In particular, between 40-49 years old, only 46 (46.9%) had acquired a Diploma or a University degree. This percentage dropped down to 34.7 (17 respondents) among the respondents between 50-59 years old and it was even lower for the respondents older than 60 years which was as low as 11.1. In Table 4.11, all the results from this cross-tabulation are presented.

Table 4.11: Cross-tabulation of the respondents' level of education and their age

Level of education	Age				
	20-29 years old	30-39 years old	40-49 years old	50-59 years old	More than 60 years old
Primary school certificate	0	0	7	11	4
High school leaving certificate	0	1	1	2	1
Lyceum leaving certificate	12	41	44	19	3
Subtotal	12 (27.9%)	42 (41.6%)	52 (53.1%)	32 (65.3%)	8 (88.9%)
Diploma	18	31	22	10	1
BSc/BA	9	26	18	6	0
MSc/MA/MBA	4	2	6	1	0
Subtotal	31 (72.1%)	59 (58.4%)	46 (46.9%)	17 (34.7%)	1 (11.1%)

(g) Position of respondents in the business and their level of education

Ninety-one (67.4%) of the owners had not acquired College or University degree. This percentage decreased down to 35.4% and 26.9% for managers and chefs respectively; but again for the production line supervisors it was as high as 47%. In Table 4.12 all the results are presented.

Table 4.12: Cross-tabulation of respondents' position in the business and their level of education

Position in the business	Level of education							
	Primary school leaving certificate	High school leaving certificate	Lyceum leaving certificate	A * (%)	Diploma	BSc/ BA	MSc/ MBA	B ** (%)
Owner	20	2	69	91 (67.4)	25	16	3	44 (32.6)
Manager	1	3	35	39 (35.4)	34	30	7	71 (64.6)
Chef	1	0	6	7 (26.9)	15	4	0	19 (73.1)
Production Line	0	0	8	8 (47)	6	2	1	9 (53)
Food Technologist	0	0	0	0	0	0	1	1 (100)
F&B Manager	0	0	1	1 (12.5)	1	5	1	7 (87.5)
Quality Control	0	0	0	0	1	2	0	3 (100)

*: Total number of respondents without Diploma or University degree. The number in brackets is the percentage.

**: Total number of respondents with Diploma or University degree. The number in brackets is the percentage.

(h) Level of education of respondents and kind of food business

Diploma was the most frequent level of education acquired among the respondents from hotels whereas the Lyceum leaving certificate from catering businesses and industries.

All results from this cross-tabulation are presented in Table 4.13.

Table 4.13: Cross-tabulation of the level of education of respondents in relation to their kind of business

Level of education	Hotel	Catering	Industry
Primary school leaving certificate	0	14	8
High school leaving certificate	1	2	2
Lyceum leaving certificate	6	59	54
Number of respondents without	7 (12.3%)	75 (75.5%)	64 (55.2%)
Diploma	24	40	18
BSc/BA	13	19	27
MSc/MA/MBA	5	1	7
Number of respondents with Diploma	42 (87.7%)	60 (24.5%)	52 (44.8%)

4.1.4 Processes, products and workforce

As shown in the following table (Table 4.14), meat and meat products were the most widely used products. It was selected by 179 (59.7%) of the respondents. Poultry and poultry products were second with 166 (55.3%) positive responses. The percentages exceeded 100 because multiple answers were given by respondents.

Potatoes (chips) and fruits and vegetables were not selected by respondents from hotels and catering businesses because meals are almost always accompanied by them.

Products, such as wine and other alcoholic drinks and water, were less frequently selected due to the fact that respondents from hotels and catering did not use them as raw material but they presented them to the consumer without any processing. Based on the principles of the division of businesses into high, medium and low-risk ones, a similar division for the products is made and presented in Table 4.15.

Table 4.14: Kind of products

Kind of products	Frequency	%
Meat and meat products	179	59.7
Poultry and poultry products	166	55.3
Milk and milk products	96	32
Fish and fish products	129	43
Rice and rice products	114	38
Bakery and confectionery products	118	39.3
Drinks and juices	64	21.3
Potatoes (Chips)	3	1
Pasta products	12	4
Wine and other alcoholic drinks	6	2
Water	7	2.3
Oil	3	1
Fruits and Vegetables	3	1
Dry nuts	4	1.3

Table 4.15: Division of products into high, medium and low-risk

High-risk	Medium-risk	Low-risk
Meat and meat products	Potatoes (chips)	Wine and alcoholic drinks
Poultry and poultry products	Pasta products	
Milk and milk products	Water	
Fish and fish products	Oil	
Rice and rice products		
Bakery and confectionery products		
Drinks and juices		
Fruits and vegetables		
Dry nuts		

This question was addressed only to the different types of food industry (n=116) in order to gather information about the processes employed. The roasting, frying and boiling processes were employed in 60 (51.7%) establishments. The baking process was used in 35 industries. This number exceeds the number of surveyed bakeries, as there were confectioneries in which bakery products were produced. All results are presented in Table 4.16.

It seems important to have a differentiation between high and medium-risk processes. However, none of the processes can be classified as low-risk, even if the raw ingredients are not sensitive. The clarification was based on the same principles as applied for the types of food industry in question 4b and products in question 5a. This categorisation is set out in Table 4.17.

Table 4.16: Processes employed by various sectors of food industry

	Frequency	%
Canning	3	2.6
Chilling / Freezing	30	25.9
Drying	15	12.9
Roasting / Frying / Boiling	60	51.7
Baking	35	30.2
Pasteurisation	22	19
Curing / Salting	18	15.5
Smoking	9	7.7
Maturation	4	3.4
UV for water	6	5.2
Filtration	7	6

Table 4.17: Categorisation of processes into high, medium and low-level risk

High-risk processes	Medium-risk processes
Pasteurisation	UV for water
Roasting / Frying / Boiling	Filtration
Chilling / Freezing	Drying
Canning	Curing / Salting
Maturation	
Baking	
Smoking	

Respondents were asked to define the total number of food handlers employed within their business site. The number of food handlers can also identify the business size. Based on this, categorisation of the businesses into large, medium and small-sized can be made. This categorisation is very important for the analysis of the results of the questionnaire. However, it should be noted that the number indicated the total number of food handlers and not the total number of employees.

European Union in its Recommendation of 3rd of April 1996, 96/280/EU suggests the following categorisation:

- Small-sized businesses: less than 49 employees,
- Medium-sized businesses: between 50 and 249 employees and
- Large-sized businesses: more than 250 employees.

However, this classification is not adequate for the categorisation of food businesses in Cyprus. 97.3% of the Cypriot businesses have less than 50 food handlers. Based on the total number of food handlers in each business, a different categorisation seems appropriate. As a result of this categorisation, there was almost the same number of businesses in each sub-category which helps in the analysis of the results. The classification of businesses was as follows:

(a) Small-sized businesses:

- 1-2 food handlers
- 3-4 food handlers
- 5-10 food handlers

(b) Medium-sized businesses:

- 11-50 food handlers

(c) Large-sized businesses:

- More than 51 food handlers

There were 220 small businesses from which 118 were catering businesses, 80 belong to different types of food industry and 22 were hotels. All the results of the categorisation of the businesses are presented in Table 4.18. The total number of businesses in each sub-category of the small and medium businesses was almost equal.

Table 4.18: Categorisation of food businesses

Category	Number of businesses				
	Hotels	Catering	Industry	Total	(%)
A. Small businesses					
1-2 food handlers	3	43	18	64	(21.3)
3-4 food handlers	1	46	24	71	(23.7)
5-10 food handlers	18	29	38	85	(28.3)
Subtotal	22 (44.9%)	118 (87.4%)	80 (69%)	220	(73.3)
B. Medium businesses					
11-50 food handlers	25 (51%)	15 (11.1%)	32 (27.6%)	72	(24)
C. Large businesses					
More than 51 food handlers	2 (4.1%)	2 (1.5%)	4 (3.4%)	8	(2.6)

The mean numbers of food handlers were 18.1, 7 and 14.4 for hotels, catering businesses and industries respectively. However, excluding the industry which had 300 food handlers then the mean number decreased to 11.9. In Table 4.19, the numbers of food handlers within each category and by type of business are presented.

Table 4.19: Number of full time food handlers

Category	Number of food handlers				
	Hotels	Catering	Industries	Total	(%)
A. Small businesses					
1-2 food handlers	5	82	34	121	(3.4)
3-4 food handlers	4	160	87	251	(7.1)
5-10 food handlers	137	181	271	589	(16.8)
Subtotal	146	423	392	961	(27.3)
B. Medium businesses					
11-50 food handlers	618	241	611	1470	(41.9)
C. Large businesses					
More than 51 food handlers	125	285	670	1080	(30.8)
Total	889	949	1673	3511	(100)

Health Certificates are issued to food handlers by the Medical and Public Health Services after microbiological stool examination for Salmonella and parasites. Food handlers take their stool samples to a hospital or private laboratory where the examination is carried out. Then the results are sent to the District Public Health Inspectors Offices where food handlers (or their representatives) go to have their Health Certificate issued if the results are negative. If however, the results are positive, and the food handler is a carrier of Salmonella or parasites, he / she has to go to the doctor to receive medical treatment and then for a second test. Food handlers from other countries have to undergo additional examinations (X-rays, Hepatitis test, HIV test) which are carried out prior the issuance of the Health Certificate. The Health Certificate is issued for one year and is obligatory for all food handlers.

Table 4.20 represents the total number of full time food handlers possessing valid Health Certificate.

Table 4.20: Total number of full time food handlers with valid Health Certificate

Total number of full time food handlers	Total number of full time food handlers with valid Health Certificate	%
3511	3439	97.9

Temporary food handlers work part-time and they are usually employed during the busy times (weekends, public holidays and summer).

Temporary food handlers in the survey are employed for longer periods in hotels and in industries other than catering businesses. They were employed in hotels from March until November but in the food industry the time of employment varied, depending on the type of industry. For example, in case of ice maker temporary food handlers were employed during the summertime only (May-October).

In catering businesses temporary food handlers were employed during the busy weekends in the summer or wintertime and on public holidays.

Seventy-six (25.3%) businesses employed temporary food handlers. Seventy-two (94.7%) of businesses with temporary food handlers were classified as small businesses. Catering businesses employed more temporary food handlers than hotels and all types of food industry. There were only 26 establishment of the food industry sector employing temporary food handlers, however the total number of food handlers was higher than in other categories as one large business employed 200 temporary food handlers.

In Tables 4.21, 4.22 and 4.23, the number of businesses employing temporary food handlers and the number of temporary food handlers are presented.

Table 4.21: Number of food businesses employing temporary food handlers.

Category	Number of businesses				
	Hotels	Catering	Industries	Total	(%)
A. Small businesses					
1-2 food handlers	4	31	17	52	(68.4)
3-4 food handlers	2	8	3	13	(17.1)
5-10 food handlers	1	3	3	7	(9.2)
Subtotal	7	42	23	72	(94.7)
B. Medium businesses					
11-50 food handlers	0	0	3	3	(3.9)
C. Large businesses					
More than 51 food handlers	0	1	0	1	(1.3)
Total	7	43	26	76	(100)

Table 4.22: Number of temporary food handlers within each category of business

Category of business	Number of temporary food handlers					
	0	1-2	3-4	5-10	11-50	>51
A. Small businesses						
1-2 food handlers	43	16	4	1	0	0
3-4 food handlers	52	17	1	0	1	0
5-10 food handlers	63	17	4	1	0	0
Subtotal	158	50	9	1	1	0
B. Medium businesses						
11-50 food handlers	60	2	4	5	1	0
C. Large businesses						
More than 51 food handlers	6	0	0	0	1	1
Total	224 (74.7%)	52 (17.3%)	13 (4.3%)	7 (2.3%)	3 (1%)	1 (0.3%)

Table 4.23: Number of temporary food handlers within each kind of business

Category	Number of food handlers				
	Hotels	Catering	Industries	Total	(%)
A. Small businesses					
1-2 food handlers	8	44	28	80	(18.1)
3-4 food handlers	7	25	11	43	(9.7)
5-10 food handlers	10	24	25	59	(13.3)
Subtotal	25	93	64	182	(41.2)
B. Medium businesses					
11-50 food handlers	0	0	60	60	(13.6)
C. Large businesses					
More than 51 food handlers	0	200	0	200	(45.2)
Total	25	293	124	442	(100)

Table 4.24 represents the total number of temporary food handlers with a valid Health Certificate.

Table 4.24: Total number of full time food handlers with a valid Health Certificate

Total number of temporary food handlers	Total number of temporary food handlers with valid Health Certificate	%
442	332	75.1

4.1.5 Inspections of the businesses by Public Health Inspectors

Through inspections, governmental bodies can determine the hygiene standards of each business in order to take the necessary measures to improve these standards if they are deemed unsatisfactory. Public Health Inspectors (under the aegis of the Ministry of Health) are responsible for the enforcement of the food legislation. They carry out sanitary inspections of all food businesses, which are registered at the Ministry of Health.

In Table 4.25, the frequencies of the inspections carried out by Public Health Inspectors are presented.

In the survey one hundred and twelve businesses (26 hotels, 48 catering and 38 industries) were inspected four times per year. The second most frequent interval between inspections for hotels was every 6 months and, for catering and food industry, every month.

Using the results of the previous table, the calculated mean numbers of inspections per year for hotels was 4.3 (every 3 months), 5.9 and 6.5 (every 2 months) for catering businesses and industries respectively.

The mean number of inspections is important in relation to the risk categories of food businesses. In Table 4.26, the frequencies of inspections of the three risk categories of businesses are presented. In Table 4.27, the mean numbers of these inspections are presented.

Table 4.25: Frequency of inspections of the businesses by Public Health Inspectors

Inspections per year	Kind of business					
	Hotel		Catering		Industry	
	Number of premises inspected	Sub-total number of inspections	Number of premises inspected	Sub-total number of inspections	Number of premises inspected	Sub-total number of inspections
Never	1	0	0	0	0	0
One	2	2	1	1	0	0
Two	6	12	8	16	5	10
Three	5	15	18	54	4	12
Four	26	104	48	192	38	152
Five	3	15	8	40	12	60
Six	1	6	15	90	23	138
Eight	1	8	11	88	5	40
Twelve	4	48	26	312	29	348
Total number of inspections		210		793		760

Table 4.26: Frequency of inspections based in risk categories of businesses

Frequency of inspections	Number of businesses inspected					
	High-risk industry (Catering and hotels)		Medium-risk industry		Low-risk industry	
	Number of premises inspected	Sub-total number of inspections	Number of premises inspected	Sub-total number of inspections	Number of premises inspected	Sub-total number of inspections
Never	0 (1)	0	0	0	0	0
One	0 (3)	0 (3)	0	0	0	0
Two	5 (14)	10 (28)	0	0	0	0
Three	3 (23)	9 (69)	1	3	0	0
Four	28 (74)	112 (296)	6	24	4	16
Five	8 (11)	40 (55)	3	15	1	5
Six	21 (16)	126 (96)	1	6	1	6
Eight	4 (12)	32 (96)	0	0	1	8
Twelve	25 (30)	300 (360)	2	24	2	24
Total	94 (184)	629 (1003)	13	72	9	59

There are 94 high-risk types of food industry, 13 medium-risk and 9 low-risk. If catering businesses and hotels are added in the high-risk category then the total number of high-risk food businesses is 278.

Table 4.27: Mean number of inspections per year of each risk category

Risk category of businesses	Mean number of inspections per year
High-risk businesses (industry only)	6.7 (every 55 days)
High-risk businesses (catering businesses and hotels)	5.5 (every 66 days)
High-risk businesses (industry, catering businesses and hotels)	5.9 (every 62 days)
Medium-risk businesses	5.5 (every 66 days)
Low-risk businesses	6.5 (every 56 days)

4.1.6 Hazard awareness

Respondents were asked to assess the level of risk to food safety and the results are given in Table 4.28. A high percentage of respondents did not consider listed hazards as hazards. Particularly, 30-40% of respondents answered that Salmonella, Staphylococcus, E. coli and spoilage organisms are not hazards for the public health. Furthermore, almost half of the respondents did not consider that Campylobacter jejuni and Clostridium botulinum as hazards.

The same attitude was observed for the chemical and physical hazards, as almost half and one-third of the respondents respectively did not consider them as hazards.

Table 4.28: Ranking of hazards

Hazards	Levels of hazards			
	High (%)	Medium (%)	Low (%)	Not a hazard (%)
A. Microbiological				
Salmonella	98 (32.7)	42 (14)	77 (25.7)	83 (27.7)
Staphylococcus	83 (27.7)	39 (13)	72 (24)	106 (35.3)
E. coli	80 (26.7)	35 (11.7)	78 (26)	107 (35.7)
C. jejuni	60 (20)	25 (8.3)	68 (22.7)	147 (49)
Clostridium botulinum	36 (12)	34 (11.3)	81 (27)	149 (49.7)
Spoilage organisms	59 (19.7)	44 (14.7)	85 (28.3)	112 (37.3)
Mean	69 (23)	36.5 (12.2)	76.8 (25.6)	117 (39)
B. Chemical				
Mycotoxins	33 (11)	39 (13)	74 (24.7)	154 (51.3)
Agricultural chemicals	38 (12.7)	37 (12.3)	72 (24)	153 (51)
Food additives	30 (10)	35 (11.7)	81 (27)	154 (51.3)
Veterinary residues	37 (12.3)	37 (12.3)	82 (27.3)	144 (48)
Mean	34 (11.5)	37 (12.3)	77.2 (25.7)	151 (50.4)
C. Physical				
Pieces of metals, stones	51 (17)	47 (15.7)	108 (36)	94 (31.3)

It is important for the analysis of the results to identify the reason why the respondents answered that the listed hazards are of high level and not hazards. One hundred and thirteen (37.7%) respondents characterised at least one of the listed hazards as of high level. In Table 4.29, the reasons why these hazards were characterised as high level are presented. The great majority (77.9%) knew that they are high hazards whereas 18 (15.9%) answered that they were warned by the Public Health Inspectors.

Table 4.29: Reasons for characterising the listed hazards as "high level"

	Frequency	%
You know that they are high level hazards	88	77.9
You were warned by the Health Inspectors that they are high	18	15.9
There was a food poisoning case in your business	4	3.5
There was a food poisoning case in another business	3	2.6

One hundred and eighty-eight (62.7%) characterised at least one of the listed hazards as not a hazard. A high percentage of respondents gave the reason for characterising the listed hazards as not hazards that they knew that they were not hazards. Another 12.2% answered that there were not favourable conditions for the presence of such hazards. All the reasons given for the "not a hazard" responses are presented in Table 4.30.

Table 4.30: Reasons for characterising the listed hazards as "not hazards"

	Frequency	%
You heard that they are not hazards	10	5.3
You know that they are not hazards	128	68
Nobody told you that they are hazards	16	8.5
They are very small and invisible	8	4.2
Public Health Inspectors told us	3	1.6
Not favourable conditions for survival of such hazards	23	12.2

To interpret this data one must take into account the handling practices of the businesses involved. For that reason, cross-tabulations between each kind of business and the ranking of hazards were made and presented in Tables 4.31, 4.32, 4.33 and 4.34.

Table 4.31: Ranking of hazards from the respondents from hotels

Hazard	High level	Medium level	Low level	Not a hazard
Salmonella	19	4	18	8
Staphylococcus	17	5	17	10
E. coli	18	2	20	9
Campylobacter jejuni	11	1	14	23
Clostridium	10	4	14	21
Spoilage organisms	11	9	14	15
Mycotoxins	9	5	11	24
Agricultural	11	2	11	25
Food additives	9	3	9	28
Veterinary residues	9	4	13	23
Physical hazards	11	5	19	14
Total (%)	135 (25%)	44 (8.2%)	160 (29.7%)	200 (37.1%)

Table 4.32: Ranking of hazards from the respondents from catering businesses

Hazard	High level	Medium level	Low level	Not a hazard
Salmonella	45	26	24	40
Staphylococcus	34	26	23	52
E. coli	32	21	24	58
Campylobacter jejuni	27	14	24	70
Clostridium botulinum	10	20	33	72
Spoilage organisms	22	22	31	60
Mycotoxins	10	22	27	76
Agricultural chemicals	14	26	27	68
Food additives	10	21	31	73
Veterinary residues	15	25	29	66
Physical hazards	24	27	33	51
Total (%)	243 (16.4%)	250 (16.8%)	306 (20.6%)	686 (46.2%)

Table 4.33: Ranking of hazards from the respondents from industry

Hazard	High level	Medium level	Low level	Not a hazard
Salmonella	34	12	35	35
Staphylococcus	32	8	32	44
E. coli	30	12	34	40
Campylobacter jejuni	22	10	30	54
Clostridium botulinum	16	10	34	56
Spoilage organisms	26	13	40	37
Mycotoxins	14	12	36	54
Agricultural chemicals	13	9	34	60
Food additives	11	11	41	53
Veterinary residues	13	8	40	55
Physical hazards	16	15	56	29
Total (%)	227 (17.8%)	120 (9.4%)	412 (32.3%)	517 (40.5%)

Table 4.34: Ranking of hazards from respondents by risk type of industry

A. High-risk types of industry (n=94)	High level	Medium level	Low level	Not a hazard
Ice cream	23	15	8	20
Dairy	31	7	12	5
Meat	18	6	41	23
Catering	13	4	5	0
Dry nuts, tahini and halva	0	11	2	9
Bakeries	42	13	81	139
Soft drinks, juices and syrups	0	11	15	29
Canning	0	1	10	0
Sub-total (%)	220 (21.3)	107	295	412 (39.8)
B. Medium-risk types of industry (n=13)				
Pasta	3	5	18	29
Seed-oil and margarine	0	1	14	18
Water bottling	4	1	33	17
Sub-total (%)	7 (4.9)	7	65	64 (44.7)
C. Low-risk types of industry (n=9)				
Flour mill	0	6	16	0
Coffee	0	0	22	0
Alcohol and spirit	0	0	14	41
Sub-total (%)	0 (0)	6	52	41 (41)

Microbiological hazards are grouped according to hazard severity. Microbiological hazards are divided into high, medium and low severity depending on the severity when the certain hazard infects humans. The classification of the listed hazards is given in Table 4.35 and is based on the Dillon and Griffith classification (1996).

Table 4.35: Categorisation of microbiological hazards

High severity	Medium severity	Low severity
Clostridium botulinum	Salmonella Campylobacter jejuni E. coli	Staphylococcus

Microbiological hazards ranking is based on the severity of the hazard and not to the likelihood of occurrence. The severity of a hazard depends upon the category of consumers (such as "at risk" groups: infants, children, old or immunocompromised), the number of people likely to be affected and the severity of the illness. The severity of the illness is largely dependant on the specific individual's health and immune system. For example, there are microbiological hazards which can be fatal for infants but may cause no illness or mild symptoms in adults (Listeria monocytogenes).

4.1.7 Good hygiene practices and systems applied in the businesses

All businesses, except one hotel, (99.7%) had regular cleaning schedules for premises and the equipment. A relatively high percentage of respondents inspected the raw materials and monitored the temperature of the equipment. Monitoring of temperature was done by using the equipment-fitted thermometer or a portable one. Microbiological testing of food was carried out by only 114 (38%) businesses, which does not seem to be of an appropriate level. Microbiological testing is very important for verification purposes.

Table 4.36: Existence of good hygiene practices

Hygiene practices	Yes	%
Cleaning schedules for the premises and the equipment	299	99.7
Inspection of raw materials	281	93.7
Temperature monitoring of equipment	267	89
Microbiological testing of food	114	38

It is also important to give the number of businesses carrying out microbiological testing within the three categories of businesses (Table 4.37). There ware only 25 catering businesses carrying out microbiological testing whereas there were 27 (55.1%) for hotels and 62 (53.4%) and businesses of the industry sector.

Table 4.37: Number of businesses within each category carrying out microbiological testing

Kind of business	Number of businesses	%
Hotel	27	55.1
Catering	25	18.5
Industry	62	53.4

A high number of respondents cleaned the equipment and the premises, inspected raw materials and monitored the temperature daily but in the case of microbiological testing the most frequent interval between the tests was one month (46.5%). In Tables 4.38 and 4.39, the frequencies of good hygiene practices carried out by the businesses are presented.

Table 4.38: Frequency of good hygiene practices

Frequency	Cleaning schedules		Inspection of raw materials		Temperature monitoring		Microbiological testing	
	Number of businesses	%	Number of businesses	%	Number of businesses	%	Number of businesses	%
Daily	283	94.6	251	89.3	232	86.9	33	28.9
Weekly	16	5.4	26	9.2	19	7.1	10	8.8
Monthly	0	0	4	1.5	15	5.6	53	46.5
Every 3 months	0	0	0	0	1	0.4	5	4.4
Every 6 months	0	0	0	0	0	0	8	7
Every year	0	0	0	0	0	0	5	4.4

Table 4.39: Frequencies of microbiological testing carried out by industries, hotels and catering businesses

Frequency	Microbiological testing			
	Hotels (%)	Food industry (%)	Catering businesses (%)	Total number of businesses (%)
Daily	2 (7.4)	22 (35.5)	9 (36)	33 (28.9)
Weekly	1 (3.7)	5 (8.1)	4 (16)	10 (8.8)
Monthly	20 (74)	24 (38.7)	9 (36)	53 (46.5)
Every 3 months	1 (3.7)	3 (4.8)	1 (4)	5 (4.4)
Every 6 months	2 (7.4)	4 (6.4)	2 (8)	8 (7)
Every year	1 (3.7)	4 (6.4)	0 (0)	5 (4.4)

Cleaning schedules, inspection of raw materials and monitoring of temperature guidelines are part of prerequisite programmes of a HACCP system. Thus, their role is very important and their implementation shows a high commitment to the implementation of an effective HACCP system. Microbiological testing is also an important part of the HACCP system but is used for verification reasons only.

In any case, it is of fundamental importance to issue the guidelines with the correct parameters in order to ensure the safe production of food. These guidelines should take into account all characteristics / parameters involved in the specific food production chain.

Any guideline should be kept up to date thus they should be checked regularly based on set intervals depending upon the type of guideline. If there are any changes in the production chain (e.g. new food products, new equipment, change of production parameters) the guidelines should be changed accordingly.

Table 4.40: Existence of written guidelines of practices

Practices	Frequency	%
Cleaning schedules guidelines	130	43.5
Inspection of raw materials guidelines	115	40.9
Temperature monitoring guidelines	118	44.2
Microbiological testing guidelines	83	72.8

The purpose of this question is to identify the internal and external bodies that issued the guidelines for the listed good hygiene practices. Guidelines that were set up by the business are considered as internal or business guidelines. External bodies are either governmental agencies or private companies. Governmental bodies include the Public Health Services, the Cyprus Tourist Organisation and the Veterinary Services. Each body issue guidelines for businesses within its field (e.g. Veterinary Services issue guidelines for dairies).

Table 4.41: Bodies that issued the listed guidelines

	Cleaning schedules		Inspection of raw materials		Temperature monitoring		Microbiological testing	
	Number of businesses	%	Number of businesses	%	Number of businesses	%	Number of businesses	%
Business	121	93	108	93.9	110	93.2	76	91.6
External consultants	1	0.8	1	0.9	1	0.8	2	2.4
CTO	1	0.8	0	0	0	0	0	0
Public Health Inspectors	6	4.6	5	4.3	6	5.1	4	4.8
Veterinary Services	1	0.8	1	0.9	1	0.8	1	1.2

This question was answered only by respondents from businesses with written guidelines in place for the listed practices. It is interesting to note that the typical interval between checking / reviewing guidelines is around 6 months. Any changes in equipment facilities or processes the guidelines need to be reviewed and, if necessary, changed. In Table 4.42 the frequencies of checks and revisions of the written guidelines are presented.

Table 4.42: Frequency of checking and reviewing of written guidelines

Frequency	Number of businesses	%
Never	10	7.3
Any time it is needed	17	12.5
Every month	1	0.8
Every 6 months	51	37.5
Every year	50	36.8
Every 2 years	7	5.1

Almost half (46%) of the businesses applied only the common sense and experience in order to ensure the production of safe food as there is no definition of "common sense", it is difficult to judge the efficiency of this parameter. Another 78 (26%) businesses applied in-house designed systems whereas only 27 (9%) and 42 (14%) applied Good Manufacturing Practices and International Standards (ISO) respectively. In-house designed system means the formal guidelines prepared by the business itself, whereas common sense and experience means that the personnel knows what to do through their experience and common sense.

Table 4.43: Food safety / Quality systems applied in the businesses

	Number of businesses	%
None	14	4.7
Common sense and experience	138	46
Public Health Inspectors' guidelines	1	0.3
In-house designed hygiene systems	78	26
GMP	27	9
ISO	42	14

4.1.8 Cross-tabulations

(a) Size of businesses and applied food safety / quality systems

Table 4.44: Cross-tabulation of size of food business and applied food safety / quality systems

Size of food business	Food safety / quality systems					
	None	Common sense and experience	Health Inspectors' guidelines	In-house designed hygiene systems	GMP	ISO
A. Small businesses						
1-2 food handlers	5	43	0	14	0	2
3-4 food handlers	3	45	0	19	2	2
5-10 food handlers	3	36	1	21	14	10
Subtotal	11	124	1	54	16	14
(%)	(5)	(56.4)	(0.4)	(24.5)	(7.3)	(6.4)
B. Medium businesses						
11-50 food handlers	3	13	0	23	7	26
(%)	(4.2)	(18)	(0)	(31.9)	(9.7)	(36.1)
C. Large businesses						
More than 51 food handlers	0	1	0	1	4	2
	(0)	(12.5)	(0)	(12.5)	(50)	(25)
Total	14	138	1	78	27	42

(b) Risk categories of industries and applied food safety / quality systems

Risk-categorization of the businesses of the food industry sector as set out in Table 4.6 is cross-tabulated with Table 4.43 (applied food safety / quality systems) and is presented in Table 4.45.

Table 4.45: Cross-tabulation of risk categories of businesses of the food industry sector and food safety / quality systems

Risk categories of businesses of the food industry sector	Food safety / quality systems					
	None	Common sense and experience	Health Inspector's guidelines	In-house designed hygiene systems	GMP	ISO
Low-risk type	0	5	0	1	0	4
(%)	(0)	(50)	(0)	(10)	(0)	(40)
Medium-risk type	0	2	0	5	1	5
(%)	(0)	(15.4)	(0)	(38.5)	(7.7)	(38.5)
High-risk type	5	46	0	20	13	10
(%)	(5.4)	(49.5)	(0)	(21.5)	(13.9)	(10.7)

(c) "High level" and "Not a hazard" responses and respondents' level of education

In the following table (Table 4.46), the level of education of respondents that ranked the listed hazards as "high level" and "not hazards" are presented. The percentages in brackets were calculated based on the total number of respondents without and with College or University Degree respectively as presented in Table 4.3 of the current Chapter.

Table 4.46: Cross-tabulation of ranking of hazards and respondents' level of education

Hazards	High level responses		Not a hazard responses	
	Without College or University Degree (%) (n=146)	With College or University Degree (%) (n=154)	Without College or University Degree (%) (n=146)	With College or University Degree (%) (n=154)
A. Microbiological (Listed hazards: 6)				
Total number of respondents	163	235	423	281
Mean number of respondents	21.2	39.2	70.5	46.8
Mean %	18.6	27.4	48.3	30.4
B. Chemical (Listed hazards: 4)				
Total number of respondents	73	67	338	605
Mean number of respondents	18.2	16.7	84.5	151.2
Mean %	12.5	10.8	54.6	44.3
C. Physical (Listed hazards: 1)				
Total number of respondents	21	30	54	42
Mean %	14.4	19.5	37	27.3

(d) Existence of hygiene practices and risk categories of the enterprises of the food industry

In the survey all enterprises of the food industry sector carried out the first type of hygiene practice and the great majority of them also performed the next two practices. As regards the last practice (i.e. microbiological testing), this was carried out by only 52.1% of the high-risk businesses of the food industry sector, 77% of medium-risk and 33.3% of low-risk businesses of the food industry sector.

Table 4.47: Cross-tabulation of existence of hygiene practices and risk categories of different types of food industry

Hygiene practices	High-risk (n=94)	Medium-risk (n=13)	Low-risk (n=9)
Cleaning schedules for the premises and the equipment	94 (100%)	13 (100%)	9 (100%)
Inspection of raw materials	92 (98%)	13 (100%)	9 (100%)
Temperature monitoring of equipment	88 (93.6%)	12 (92.3%)	9 (100%)
Microbiological testing of food	49 (52.1%)	10 (77%)	3 (33.3%)

(e) Size of businesses and the existence of hygiene practices

This cross-tabulation (Table 4.48) is very important and its purpose is to identify if the size of business is a factor that affects the existence of hygiene practices within the businesses.

Table 4.48: Cross-tabulation of size of business and the existence of hygiene practices

Size of business	Hygiene practices			
	Cleaning schedules	Inspection of raw materials	Temperature monitoring	Microbiological testing
A. Small businesses				
1-2 food handlers (n=64)	64 (100%)	54 (84.4%)	51 (79.7%)	8 (12.5%)
3-4 food handlers (n=71)	71 (100%)	67 (94.4%)	61 (85.9%)	18 (25.3%)
5-10 food handlers (n=85)	84 (98.8%)	82 (96.5%)	79 (92.3%)	34 (40%)
Subtotal (n=220)	219 (99.5%)	203 (92.3%)	191 (86.8%)	60 (27.3%)
B. Medium businesses				
11-50 food handlers (n=72)	72 (100%)	70 (97.2%)	68 (94.4%)	46 (63.9%)
C. Large businesses				
More than 51 food handlers (n=8)	8 (100%)	8 (100%)	8 (100%)	8 (100%)
Total	299	281	267	114

4.1.9 The HACCP system

4.1.9.1 Information on the HACCP system

From the results presented in Table 4.49, it is clear that just over half (55%) of the respondents knew what the HACCP system is.

Table 4.49: Frequencies of responses to the question "What is HACCP?"

	Frequency	%
Irradiation technique to eliminate pathogenic microorganisms	2	0.7
Risk management system applied in food businesses	165	55
Do not know	133	44.3

Only information on respondents who selected a valid answer in the previous question was considered for the purpose of this survey. Ninety-one (55%) and 88 (53.3%) of respondents obtained information from the Public Health Inspectors and external consultants respectively. All the results are presented in Table 4.50. Percentages exceed 100 because multiple answers were given by respondents.

Table 4.50: Sources of information on the HACCP system

	Frequency	%
External consultants	88	53.3
Colleges and Universities	49	29.7
Other businesses	10	6
Public Health Inspectors	91	55
Internet	12	7.3
Seminars	36	21.8

Only respondents who gave the right answer to the 13th question were considered for the purpose of this survey. The HACCP system was implemented in only 51 food businesses, thus 30.9% of food businesses the respondents of which knew what the

HACCP system is. If however, the percentage is calculated on the total number of surveyed businesses (n=300) then this figure drops down to 17%.

Thirteen (26.5%) hotels, 13 catering (9.6%) businesses and 25 (21.5%) industries implemented the HACCP system.

Table 4.51: Implementation of the HACCP system

	Kind of business			
	Hotels	Catering	Industries	Total
Number of businesses applying HACCP	13	13	25	51 (17%)
Percentage based on the number of businesses of each category	26.5	9.6	21.5	

The HACCP system was firstly implemented in 1996 by two businesses (Table 4.52). Only after 1997, the number of such businesses increased. In the first three months of 2001, 3 additional businesses implemented the system.

Table 4.52: Year of implementation of the HACCP system

	Year of implementation																	
	1996			1997			1998			1999			2000			2001 (January-March)		
	H	C	I	H	C	I	H	C	I	H	C	I	H	C	I	H	C	I
Frequency	0	0	2	0	0	2	2	3	4	3	4	6	8	6	8	0	0	3
Total	2			2			9			13			22			3		
%	3.9			3.9			17.6			25.5			43.1			5.9		

As discussed before, 51 businesses have applied the HACCP system. When asked about the source of assistance they had for the development and the implementation of the HACCP system, the great majority of respondents (76.5%) replied that they sought help from external consultants (Table 4.53).

Table 4.53: Sources of help for the development and implementation of HACCP

	Frequency	%
With the aid of the Government	5	9.8
With the aid of external consultants	39	76.5
With your own	7	13.7

Businesses implemented HACCP based on different grounds but the prominent reason given by respondents was the increase in the safety of food produced in their business (Table 4.54). The second most frequent given reason was a commercial advantage to the products produced in their business. It should be noted that implementation of the HACCP system was not a legal requirement at the time of conducting the survey. Customer pressure was the second least selected reason (25.5%) for the implementation of the HACCP system.

It should be noted that figures in brackets are the percentages and they were calculated based on the total number of businesses of each category which had the HACCP system in place. In addition, the calculated percentages for the total results exceeded 100 because respondents gave multiple answers to this question.

Table 4.54: Reasons for implementing the HACCP system

Reasons for implementing the HACCP system	Hotel (%)	Catering (%)	Industry (%)	Total (%)
To increase the safety of food produced in the business	12 (92.3)	12 (92.3)	24 (96)	48 (94.1)
Due to customer pressure	8 (61.5)	1 (7.7)	4 (16)	13 (25.5)
Due to impending legal requirements	3 (23.1)	3 (23.1)	6 (24)	12 (23.5)
To give commercial advantage to the products of the business	6 (46.1)	5 (38.5)	15 (60)	26 (51)

4.1.9.2 Auditing of the HACCP system

Audit was defined as "a systematic and independent examination to determine whether activities and results comply with the documented procedures; also whether these procedures are implemented effectively and are suitable to achieve the objectives" (Mortimore & Wallace, 1994: 164).

The HACCP system of thirty businesses (58.8%) was externally audited (Table 4.55). Government audited 12 (23.5%) businesses, international agencies 7 (13.7%) and private consultants / auditors the remaining 11 (21.6%).

Table 4.55: Auditors of businesses implemented the HACCP system

Auditor	Kind of business			Total	%
	Hotel	Catering	Industry		
Government	1	5	6	12	23.5
International Agencies	4	3	0	7	13.7
Private consultants/auditors	2	1	8	11	21.6
Total number of audited businesses	7	9	14	30	58.8

4.1.9.3 Enhancing knowledge on the HACCP system

Only respondents from businesses which implemented the HACCP system were considered for the purpose of this survey. Their opinion was considered more reliable and practicable (in relation to the ways of improving the knowledge about the system) because of their personal involvement in the development and sustaining it.

The ways of improving the knowledge about the System was divided into two categories. The first category included the actions / ways from the Government and the second category was the help given by private experts / consultants.

In the respondents' opinion, governmental agencies should conduct more seminars in order to educate all food handlers better on the System. All responses to this question are presented in Table 4.56.

Table 4.56: Ways of improving knowledge on the HACCP system

	Frequency	%
Seminars from governmental agencies	28	55
Seminars from private experts/consultants	13	25.5
Publications from the Ministry of Health	6	11.7
Use of the Internet	2	3.9
Establishment of a governmental HACCP board	2	3.9
Total	51	100

4.1.10 Cross-tabulations

(a) Size and number of businesses applying the HACCP system

The number of full-time food handlers, as noted in Chapter 4.1.4, determines the size of business. The results of this cross-tabulation are useful as for the purpose of comparison with the results of the Crete study.

Table 4.57: Cross-tabulation of the size of businesses (number of full-time food handlers) and the implementation level of the HACCP system

Category of business	Number of businesses implemented the HACCP system	Total number of businesses	%
A. Small businesses			
1-2 food handlers	2	64	3.1
3-4 food handlers	7	71	9.8
5-10 food handlers	14	85	16.5
Subtotal	23	220	10.4
B. Medium businesses			
11-50 food handlers	23	72	31.9
C. Large businesses			
More than 51 food handlers	5	8	62.5

(b) Years of operation and number of businesses applying the HACCP system

The duration the businesses been in operation is cross-tabulated with the implementation level of the HACCP system and the results are given where there is a correlation between the two.

Table 4.58: Cross-tabulation of the years of operation of the businesses and the implementation level of the HACCP system

Years of operation	Number of businesses implemented the HACCP system				Total number of businesses	%
	Hotel	Catering	Industry	Total		
1-5	2	5	7	14	70	20
6-10	2	5	7	14	80	17.5
11-15	3	0	3	6	60	10
> 16	6	3	8	17	90	18.9

(c) Correlation of information of the HACCP system and size of food businesses

The results of this cross-tabulation determine whether the size of the businesses influence the knowledge of respondents about the HACCP system. The figures in brackets are the percentages of respondents (businesses) who gave the specific answer.

Table 4.59: Cross-tabulation of definition of the HACCP system and size of food businesses

Size of business	What is HACCP?		
	Irradiation technique to eliminate pathogenic microorganisms	Risk management system applied in food businesses	Do not know
A. Small businesses			
1-2 food handlers	0	14	50
3-4 food handlers	1	27	43
5-10 food handlers	1	55	29
Subtotal (%)	2 (0.9)	96 (43.6)	122 (55.4)
B. Medium businesses			
11-50 food handlers (%)	0 (0)	62 (86.1)	10 (13.9)
C. Large businesses			
More than 51 food handlers (%)	0 (0)	7 (87.5)	1 (12.5)
Total (%)	2 (0.7)	165 (55)	133 (44.3)

(d) Risk categories of businesses and level of implementation of the HACCP system

This cross-tabulation gives the level of implementation of the HACCP system in the risk categories. In the case of the high-risk businesses, further subdivision was made to give a clearer picture of the actual condition. As noted in Question 4b of this Section, catering businesses and hotels are considered as high-risk businesses (because they handle various sensitive raw materials).

In the case of the medium and low-risk businesses, they can also be considered as to be medium and low-risk businesses of the industry sector.

All results of this cross-tabulation are given in Table 4.60.

Table 4.60: Cross-tabulation of the risk categories of businesses and the implementation of the HACCP system

Risk category of business	Total number of businesses	Businesses implementing the HACCP system	%
High-risk businesses:			
a) High-risk types of food industry, catering businesses and hotels	278	45	16.2
b) Catering businesses and hotels	184	26	14.1
c) Catering businesses only	135	13	9.6
d) Hotels only	49	13	26.5
e) High-risk types of food industry only	94	19	20.2
Medium-risk businesses (industries)	13	5	38.5
Low-risk businesses (industries)	9	1	11.1

4.1.11 Reasons for not having the HACCP system in place

This Question was addressed to the respondents, who knew about the HACCP system but it was not in place in their businesses.

The most frequent reason selected was that the HACCP system was not legally required following by the reason "It is at the development stage". All the results of the question are presented in the following table (Table 4.61).

Table 4.61: Reasons for not having the HACCP system been implemented

	Frequency (n=116)	%
It is not required	13	11.2
Nobody knows about it	4	3.4
There is no a legal requirement	48	41.3
It costs too much money	13	11.2
It is at the development stage	38	32.7

Cost is an important factor when somebody has to take a decision for any new development. In the previous question, 13 respondents answered that their business had not developed the HACCP system because of the costs involved.

More than half of the respondents (61.6%) thought that the development and implementation of the HACCP system would cost more than 51,001 Euros. All the results of this question are found in Table 4.62.

The percentage was calculated based on the total number of respondents answered that the development and implementation of the HACCP system would cost too much money in Q. 20a (n=13).

It is interesting to know that many respondents estimated the costs of the HACCP system development and implementation to be higher than the real costs involved. It is unclear where this perception of high costs originated. However, as the number of HACCP consultants is small, their charges are very high.

Table 4.62: Estimated cost of HACCP development and implementation

Euros	Frequency			Total	%
	Hotels	Catering businesses	Industries		
Up to 17,000	0	2	1	3	23.1
17,001 – 34,000	0	0	1	1	7.7
34,001 – 51,000	0	0	1	1	7.7
51,001 – 68,000	1	0	2	3	23.1
68,001 – 85,000	1	0	3	4	30.8
More than 85,001	1	0	0	1	7.7

4.1.12 Development and implementation of the HACCP system

Every company has business plans for the future and especially when they are legally required to develop the HACCP system. More than half of the respondents answered that they would not develop and implement the HACCP system unless "it is a legal requirement" (see also Chapter 4.1.11). Another 28.4% of respondents claimed that they would develop and implement the System in 2001 (the survey was conducted in 2000). At present it is impossible to verify whether these businesses have done what they promised. All results of this question are found in Table 4.63.

Table 4.63: Year of development and implementation of the HACCP system

	Frequency	%
Not at all unless it is a legal requirement	60	51.7
This year	33	28.4
Next year	13	11.2
In two years	7	6
After three years	3	2.6

4.2 Discussion of the results of the Cyprus survey

As discussed in Chapter 3.2 the questionnaires were completed before a follow-up interview and therefore the returns were almost 100%. The survey covered a total number of 300 food businesses, which represents the 6.9% of the total number of food businesses in Cyprus. This number of surveyed businesses can be characterised as statistically significant (Vlachonikolis I, 2000, personal communication). In HACCP surveys carried out in UK and Ireland the percentages of businesses covered were lower and around 4% (Mortlock *et al*, 1999; Ehiri *et al*, 1997a; Food Safety Authority of Ireland, 2001).

4.2.1 Age of respondents and position in the business

Most respondents were between the ages of 30 and 49. This distribution of respondents' ages was similar to the results of another survey of food businesses conducted for a different purpose which was carried out in Canada in 1989 (Cunningham, 1993). In that survey the majority of respondents (54.5%) were between 30-49 years old. This range of age is not surprising, as most people have already embarked on a career after they finished their studies. Furthermore, most of them are starting their own family so they need a steady income and some job prospects.

Based on the results of Table 4.2, the 55% of the respondents were employees and only 45% were owners. This is lower overall percentage compared with the results of a survey carried out in California among the restaurant operators in which the owners represented the 65% of the total number of respondents (Cochran-Yantis *et al*, 1996). In the survey carried out in Ireland in 2000, 49% of respondents were the owners and the remaining percentage was employees (34% managers, 17% chefs, cooks and other staff) (Food Safety Authority of Ireland, 2001). The reasons given for that were:

(a) The owners were not present at the time of a visit to the business,

(b) The owners do not deal directly with food safety matters as there is a designated person responsible for food safety matters and

(c) The owners do not have the necessary knowledge to answer the questionnaire.

Most of the catering businesses and food industry in Cyprus are small, family run businesses, thus, the owner has to deal with the food safety / hygiene matters as well. On the other hand, as most hotels employ a substantial number of staff, there is a specific person who deals with food hygiene and safety matter and in most cases this is the Food and Beverage manager.

The results of Table 4.2 show that the smallest number of owners (4 out of 49) was in hotels, 63 out of 135 in catering businesses and 68 out of 116 in different types of food industry respectively. In most cases larger businesses have designated person to deal with the food safety matters. In many cases these businesses are quite large, and have extensive management structures (on average, just over 50 employees).

4.2.2 Level of education of respondents and kind of food business

Primary education means from grade 1 to 6, the high school means up to grade 9 and the lyceum means up to grade 12. Diploma is obtained after 2 or 3 years of a college course, which generally are private. The only University which is established on the island is the University of Cyprus. Altogether, there are 30 non-University public and private institutions which provide higher (tertiary) education (Statistical Service of the Republic of Cyprus, 2000b).

The Cyprus survey covered the three categories of food businesses i.e. hotels, catering businesses and different types of food industry. Industry and hotels represent 11.2% and 11.4% respectively whereas catering businesses 5% of the total number of each kind of business.

4.2.3 Cross-tabulations

(a) Age of respondents, position in the business and type of food business

The owners and managers of catering businesses (aged 20-29) form a larger group than the owners of food industry. A catering business is usually a small family business (less than 5 food handlers) and can be a restaurant, tavern, pizza or take away.

Under the Catering and Entertainment Establishments Law of 1985 and the Catering and Entertainment Establishments Regulations of 1986 (Official Gazette of the Republic of Cyprus, 1985 and 1986), the manager of a catering business should possess:

(a) A Diploma of a College (Hotel and Tourism College),

(b) A Lyceum leaving Certificate plus at least one year of experience in this sector and

(c) Experience in this sector accepted by the Cyprus Tourist Organisation as adequate (Human Resource Development Authority, 1995). The minimum experience, which is considered adequate, is 3 years if the person holds a lyceum leaving certificate and minimum 5 years if the person does not hold a lyceum leaving certificate. This condition only applies for C Class restaurants.

However, the above provisions do not apply for the managers of catering business that were established before 1985 when the above Law and the Regulations came into force.

In Cyprus, anyone can start and run such a business when he / she has the necessary knowledge or experience (as given above) with relatively low costs. However, these conditions do not explain the distribution of owners and managers of businesses who are more than 30 years old.

The respondents were divided into the three categories (hotel, catering and different types of food industry) based on their position in the company (i.e. chefs, production line supervisors, food technologists, food and beverage managers and quality control supervisors). As in many cases, companies were not informed about the visit of the author of this survey, the availability of specific employees in a company determines the distribution.

(b) Age and level of education of respondents

Based on the results of Table 4.11 of the previous section, it is obvious that younger respondents have higher level general education than the older ones. This is a reflection of the general situation in Cyprus; young people tend to be well-educated. In the 1998-1999, 72.4% of the Lyceum leavers continued their studies in Colleges or Universities in Cyprus and abroad (Statistical Service of the Republic of Cyprus, 2000b).

(c) Position in the business and level of education of respondents

Owners were found to have the lowest level of education of the respondents, as 67.4% have only Lyceum leaving certificate. This is due to the fact that most of them (64.4%) are older than 40 years and they did not enjoy the opportunities currently available in Cyprus. Until the 1960's, there were no higher educational establishments in Cyprus. The only way to acquire such degrees was to study abroad (usually in Greece or UK). The problem of lack of education is less prominent between the ages of 20 to 39 because by that time the first colleges were founded on the Island. Another reason was that people could establish any kind of business, especially a catering or a food processing one, without having a College or a University Degree, even without a secondary school education until 1985.

The level of general education of respondents who were not the owner was higher, as most of them possessed a Diploma or University Degree. Currently, the competition for such positions ensures that education, knowledge, and experience in the field are of high levels.

(d) Level of education of respondents and kind of food business

Respondents from hotels had higher levels of education than respondents from the food industry and catering businesses. Hotels, large enterprises of food industry and catering businesses have more structured management systems. They can afford a qualified person in each position. This is the reason that hotels employ better educated people, followed by different types of food industry and catering businesses.

4.2.4 Processes, products and workforce

More respondents identified meat, poultry, milk, fish, rice, bakery, confectionery and their products, because these products are handled in almost all hotels and in the majority of catering businesses. On the other hand, respondents from the food industry selected only the kind of products that are associated with the type of company they work in. So, their contribution to the total number of products was not very significant.

As shown in Tables 4.16 and 4.17, the high-risk processes are used more frequent than the medium-risk processes. This fact has be taken into consideration analysing the ranking by respondents of microbiological, chemical and physical hazards according to their importance for public health.

The number of full time food handlers is a very important criterion for the classification of businesses. Cyprus is a small island and, therefore, the great majority of food businesses are small, as shown in this survey. In Table 4.18, 73.3% of the surveyed businesses are shown to be small and another 24% are medium businesses giving a total figure of 97.3%. These figures in the case of Cyprus and EU as a whole, with regard to the total number of manufacture businesses, are 99.2% and 96.5% respectively (Human Resource Development Authority, 1999). In a survey carried out in Ireland, 37% of the surveyed businesses employed less than 5 employees, 14% between 5 and 10, 12% between 10 and 20 and 14% more than 20 employees (Food Safety Authority of Ireland, 2001).

Such figures demonstrate that a substantial proportion of food is produced, processed and sold by small businesses and, therefore, that the safety of their operations affects in a major way the integrity of the entire food production.

Other characteristics of small businesses in Cyprus are as follows:

- They serve local customers,
- They have a limited share of the available market,
- They are owned by one person or by a small group of people, are managed by their owners who deal with all management issues, usually with little help, and
- They are independent businesses.

The possession of a valid Health Certificate is mandatory and is laid by the Hygiene of Official Control of Foodstuffs Regulations of 2002 (Official Gazette of the Republic of Cyprus, 2002) (see also Chapter 2.2.6). Before 6th April 2002 when the new Regulations came into force, the Hygiene of Foodstuffs (General) Regulations of 1970 were in force and Article 17 of these Regulations obliged food handlers to posses a valid Health Certificate (Official Gazette of the Republic of Cyprus, 1970).

Health Certificate is a certificate issued to food handlers by the Public Health Services after microbiological stool examination for Salmonella and parasites based on the procedure described in Chapter 4.1.4.

Public Health Inspectors in Cyprus are very diligent in demanding a valid Health Certificate from all employees of food businesses. The percentage of employees with a valid Health Certificate, as shown in Table 4.20 is relatively high taking into account the fact that there may be employees for whom the Health Certificate procedure for renewing the certificate have commended.

One disadvantage that arises from the fact that the Health Certificate is issued only once a year is that the health status of any employee is determined only on the date when the tests were carried out but remains valid for the whole year. Thus, a good practice that can be followed by Inspectors is to check as many employees as possible in every inspection. In this way, he / she at least can find out if there are any symptoms of ill-health which are visible with the naked eye. The level of hygiene of an employee can be determined by visual examination: the cleanliness of his / her clothes and body, if he / she has any wounds or cuts on his / her hands and if he / she wears the appropriate clothes.

The way a Health Certificate is issued poses another problem, that there is no verification if the sample taken to a laboratory from a food handler is in fact his / her sample. For that reason Public Health Inspectors during their visits to the food businesses usually make the owners, managers and all food handlers understand and follow the right procedure for the issue of the certificate.

The great majority of temporary food handlers are employed by small-sized businesses and, in particular, by catering businesses employing up to 4 full-time food handlers. These businesses are family run businesses, their turnover does not allow them to employ permanent staff. Thus, they employ food handlers only when and for as long as they are needed.

There are many problems arising from such practices. First of all, temporary food handlers do not pay attention for the proper hygiene procedures during work because of the lack of motivation. They are not motivated to take interest in food hygiene / safety matters due to the temporary nature of their work. As a result, they do not participate in any formal training organised by the business, government or private consultants for the permanent staff.

A way to moderate of these problems is to persuade the head of the businesses employing temporary food handlers that it is better to employ the same people every time and to train them in the basic food hygiene and safety matters during their employment. A second way, which is a requirement laid in the legislation, is the possession by each food handler (even if he / she is a temporary worker) of a valid Health Certificate.

The number of temporary food handlers with a valid Health Certificate was however found to be very small (Table 2.24). It is evident that efforts must be made to ensure that as many temporary food handlers as possible possess a valid Health Certificate and follow a basic food hygiene training.

4.2.5 Inspections of the businesses by Public Health Inspectors

The primary goal of a food inspection programme is to protect the public from foodborne diseases. This goal is best achieved with regular inspections of food businesses by trained inspectors during which poor/good hygiene practices and substandard environmental conditions are identified and ways to remedy them are found.

This traditional approach has its weaknesses, the most important of which are as follows (de Sitter *et al*, 1998):

- Terms contained in laws are frequently of a general nature in order to be applicable to different settings,
- These terms leave much to the discretion of inspectors who may fail to distinguish between important and relatively unimportant requirements. The latter is also due to the undifferentiated uniform weight of requirements in regulations,
- As modern technologies are introduced, which are covered only partially by current legislation, the official inspector may overlook factors which are critical to safety,
- Any official inspection is limited with regards to time. Thus, the inspector's observation relate only to a portion of a particular process at a given point of time.

As regards the results presented in Tables 4.25, 4.26 and 4.27, it is obvious that all food businesses were inspected at regular intervals. The frequency of Public Health Inspectors visits help in assessing and improving the hygiene status of all food businesses. All industries are inspected every two months and all hotels and catering businesses every 66 days, so their progress can be checked.

A survey carried out in the US restaurant showed the more frequent the inspections are, the higher the levels of hygiene and food safety at the restaurant (Allwood *et al*, 1999). Poor results on routine inspections have been shown to be predictive of subsequent outbreaks of food poisoning (Irwin *et al*, 1989).

However, inspections should be varied so as to accommodate all changes that have been introduced in the whole food chain, from the production to the consumption stage. Many food safety and quality systems applied in food businesses are based on a proactive and preventative approach, moving away from the notion of end product testing. For that reason the role of Public Health Inspectors is much more vital. They have to check and audit the efficiency of these systems in every visit to food businesses. However, as discussed in Chapter 2.6 Public Health Inspectors are faced with emerging hazards. As American experience showed, for many small businesses, their sole source of information about food safety issues and legislation comes from food safety enforcers (Rennie, 1994). It seems that the same trend is developing in Cyprus and where focus is centred on those businesses with the greater risk of causing foodborne diseases Inspectors have to act in an advisory rather than inspectorial capacity.

Last, but not the least, the role of consumers in achieving safe food must be considered. As food handlers are also consumers, they have the right to be informed about food hygiene and safety and have responsibility to handle food properly. Thus, Public Health Inspectors should consult with consumers on food inspection strategies and support efforts of consumer education.

4.2.6 Hazards awareness

All people working in the food businesses must be aware of the hazards that may be present in any food they produce and handle and their significance to public health. In Chapter 2.4 data on microbiological, chemical and physical hazards associated with food production and handling is discussed.

All food handlers must be advised on the measures that should be taken to minimise the possibility of a foodborne disease occurrence. On the other hand, the management of businesses is a central element of sustaining the safety and hygiene of its products. The management is responsible for all food hygiene and safety issues because everything starts and ends from its decisions and actions.

The results of Table 4.28 suggest that businesses did not recognise microbiological hazards that were significant to their products and processes. Among the listed microbiological hazards, Salmonella was categorised as "high risk" by the highest percentage of respondents. It reflects the fact that a lot of publicity was given by mass media to Salmonella food poisoning in Cyprus and, therefore, it is well known (Ehiri *et al*, 1997a). Salmonella was also characterised by the smallest number of respondents as "not a hazard" compared to other hazards but this percentage was still very high. For the remaining hazards (except for the spoilage organisms) the "high risk" responses decreased and the "not a hazard" responses increased progressively.

As regards the chemical hazards, half of the respondents did not consider them as hazards. This is a very high figure indeed. The effect of chemical contamination on the consumer can be long-term (chronic) or it can be short-term (acute). In both cases the severity of the effects may be very high and in any case chemical hazards are of high risk.

Physical hazards were classified more frequent than chemical hazards as "high level" risk but less frequent than microbiological ones. These hazards are the most commonly reported to be found in foods because they are very easily identified as the ill health effects occur immediately or soon after eating.

Generally, there are two driving forces for food handlers to understand and recognise the importance of microbiological, chemical and physical hazards. The first one (and the most important one) is the knowledge they have, gained from their education, training and / or experience. The second force is the publicity and public health warnings when a given hazard has been linked with an outbreak or the consequences of this food poisoning outbreak. Therefore, it is the former force that should be reinforced in order for the food handlers to be able to recognise the importance of all hazards that can be found in their kind of business.

In Table 4.29, respondents gave the grounds for ranking the listed hazards as "high level" risk. The choice of reasons made by respondents about the listed hazards of "high level" was correct. However, it should be noted that the answer "You know that they are high level hazards" was the most appropriate as it showed that the respondents knew the answer because of their education and / or training.

On the other hand, the reasons for the "not a hazard" responses were different (Table 4.30). A known hazard can be characterised as "not a hazard" only in the case that the products produced and handled in a specific kind of business do not allow the survival and growth of the microbiological or chemical hazard under question. Thus, the correct answer was "Not favourable conditions for survival of such hazards". Another reason that could have been accepted, but was more questionable: "you know that they are not hazards". However, only in very limited cases is a given hazard not considered to impose any risk for a specific procedure during food production and handling. One example is the Clostridium botulinum which is found only during anaerobic production conditions (canned food).

Very different information is derived from Tables 4.31, 4.32 and 4.33. Respondents from hotels seemed to be more aware of hazards as they represented the highest percentage of respondents answering "High level" and the least percentage answering "Not a hazard". On the other hand, respondents from catering businesses were the least aware of these hazards. The awareness of these hazards of respondents from the food industry was not as high as that of respondents from hotels.

As the economy of Cyprus is based on the tourist sector, the Government was and still is spending a lot of resources in this sector in order to attract tourists to Cyprus. However, through the years, in order to provide assurance to the tour operators of the high standards of food hygiene and safety throughout Cyprus hotel industry, the management of each hotel was spending much more extensively on training than the catering and food industry sectors to ensure standards were at high levels. Tour operators are trying to set even stricter criteria for the selection of hotels due to western customers' pressure.

As noted in Chapter 4.1.2, catering businesses are characterised as high-risk businesses because of the products they handle. In addition, Sheppard *et al* (1990) based on statistical evidence, indicated that outbreaks of food poisoning are most commonly associated with this sector. In this survey, it was expected that respondents from catering businesses would have regarded theirs as high-risk businesses. However, this was not the case as only 16.4% of respondents assessed their businesses' in terms of food safety as high level. These results are similar to the survey carried out by Mortlock *et al* in 1999 in UK where only 16% of respondents from retail and catering sector identified themselves as high-risk in terms of food safety. The similar distribution of results, between the two surveys, was observed for the remaining medium and low-level risk responses.

The results of Table 4.34 for the responses given from the high-risk industries showed only a very basic understanding of hazard severity as only 21.3% acknowledged the listed hazards as "high level". This percentage was similar to another survey carried out in UK in which 21% of respondents from the food industry sector identified themselves as high risk (Mortlock *et al*, 1999). Further, the percentage of the "Not a hazard" responses (39.8%) is evidently a major underestimation of the hazards involved.

In the case of medium and low-risk industries the percentage for "high level" responses was very low and for "Not a hazard" responses very high. In both cases, these results clearly showed that there is a serious lack of understanding of the significance and severity of these hazards to public health.

4.2.7 Good hygiene practices and systems applied in the businesses

Cleaning practices are most important for every food business. This means that the management of the business have an established cleaning schedule for the equipment and for the areas inside and outside the premises. The intervals between the cleanings usually are based on the area to be cleaned, the kind of products handled and the risk factor involved.

Almost all respondents confirmed that cleaning schedules for the premises and the equipment were in place (Table 4.36).

Inspection means the microscopic (e.g. microbiological analysis etc.) and macroscopic checking (e.g. appearance, odour etc.) of any material. In this survey, the macroscopic checking of raw materials is under consideration. This practice is usually carried out in two stages, the first at the time of delivery of raw materials and the second, when these materials are going to be used in the production.

From the results, a high percentage of businesses seemed to carry out this practice (Table 4.36). Indeed, the persons responsible for the deliveries in almost all food businesses were very careful when receiving the raw materials. Beyond the risks to public health of possible use of unsuitable raw materials for human health, receiving of such materials may lead to economic losses, a fact that appears to be well recognised in Cyprus.

As discussed in Chapter 2.4.1, temperature is one of the most important factors that can be used to minimise the number of microorganisms that may be present in a food product.

The percentage of businesses employing temperature monitoring can be characterised as satisfactory regarding the fact that at the time of the survey, there was no legal requirement for the businesses to carry out this practice because the General Food Hygiene Regulations of 1970 were in force. Under these circumstances, a problem that arises is the lack of documentation of this monitoring practice and the measures taken when standards, if any, are not met. Temperature monitoring with a satisfactory documentation system became a legal requirement for all food businesses since the new Hygiene and the Official Control of Foodstuffs Regulations of 2002 entered into force (Official Gazette of the Republic of Cyprus, 2002).

The role of microbiological testing is of particular interest, although this is a practice which is carried out infrequently in the surveyed businesses. Traditional end product testing is less practical within catering businesses and hotels due to the short lead times between production and consumption. On the other hand, in the case of industries where the products will not be consumed in a very short time, microbiological testing can be very useful.

The results of the survey showed that microbiological testing is not a common practice. Comparing these results with a survey carried out in UK, this practice is more common among catering businesses in Cyprus than in UK. In the UK survey only 7.9% of catering businesses carried out this practice (Mortlock *et al*, 1999). On the other hand, only 53.4% of the food industry enterprises in Cyprus carried out microbiological testing compared to 71% in UK (Mortlock *et al*, 1999).

Another survey carried out earlier in Glasgow, showed that microbiological sampling was not undertaken by any of the surveyed catering businesses (Ehiri *et al*, 1997a). Instead, 78% of them retained meal samples for microbiological testing in case of suspected food poisoning (Ehiri *et al*, 1997a).

In any case, a random sampling of products for microbiological analysis is very helpful as the results of the analysis can give valuable information on the hygiene status of the businesses and of the practices followed by food handlers. Furthermore, an understanding of the use of microbiological criteria within HACCP plans is arguably fundamental to their success (Buchanan, 1995).

The first three practices, namely cleaning schedules of the equipment and the premises, inspection of raw materials and temperature monitoring of equipment, were carried out almost every day by some of the businesses (Table 4.38). What should be commented on is the frequency of the microbiological testing carried out in hotels, industries and catering businesses. Three quarters of hotels in this survey carried out microbiological testing every month. As it is known, a huge variety of dishes are prepared in hotels so, such testing should include samples of all dishes.

On the other hand, a similar number of industries and catering businesses carry out this practice with the same frequency. However, these frequencies are not very impressive for either group.

The existence of written guidelines in any kind of business is of paramount importance, as all employees need to be made aware of the proper procedures to be followed. Less than half of businesses in this study had written guidelines in place for practices other than the microbiological testing of food (two-thirds of businesses had established for this purpose written guidelines). Guidelines make possible to trace omissions and mishandling of food during work that may lead to the production of unsafe food.

In the case of written guidelines for the microbiological testing of food, the percentage was higher because in most cases there was a written agreement between the business and the laboratory specifying the frequency with which the laboratory accepted food samples for analysis.

Almost all written guidelines were issued by the businesses. However, it should be noted that these guidelines were issued by the businesses either themselves or with the aid of external consultant or governmental departments (e.g. Cyprus Tourist Organisation and Public Health Inspectors). In either situation, it is of fundamental importance to issue the guidelines with the correct parameters in order to ensure the safe production of food. These guidelines should take into account all characteristics/ parameters involved in the specific food production chain.

Any guideline should be kept up to date and checked at set intervals depending upon the type of guideline. If there are any changes in the production chain (e.g. new food products, new equipment, change of production parameters) the guidelines should also be changed accordingly.

The great majority of businesses in this survey checked and reviewed the written guidelines every 6 to 12 months, an interval which can be considered as satisfactory assuming that there are not any changes which need immediate alterations of the guidelines.

A "system" is a stepwise process for carrying out a specific duty or action. In any kind of business there is a system, either widely acceptable by the employees or not. This system may be just a way of thinking or a "known by heart" way of acting in every given situation. The best scenario is the existence of a documented and widely acceptable system, which ensures that the food safety standards set by the regulatory authority or consumers are met.

Almost half of businesses in the survey ensured the safety of food using their common sense and experience. However, common sense and experience differs from person to person, and this "system" cannot be used to verify its effectiveness for production of safe food. Thus, dependence on this method of working is not reliable and cannot guarantee the safety and quality of food. Where, there are no specified guidelines and directions to be followed during work the safety and quality of food depends unsuitably on the knowledge appreciation of the person involved.

The in-house designed hygiene systems were based on oral or written guidelines given to food handlers by the management of the business in this study. In many cases, these guidelines may not be scientifically based. For the purposes of the analysis of the results of the present survey, the in-house designed hygiene systems are not considered as an effective method to ensure the production of safe food.

On the other hand, the remaining of the listed systems can be characterised as satisfactory because they are widely used and acceptable all over the world. Of course, ISO (International Standard Organisation) has to do more about the quality of the food products and not for their safety, however it is a very important and useful starting point for establishing an effective food safety management system.

4.2.8 Cross tabulations

(a) Size of food business and applied food safety / quality systems

As might be expected, the size of the business is an important factor for the application of a suitable and effective food safety / quality system. Thus, smaller businesses are less likely to have a food safety / quality system in place due to financial and other pressures.

The importance of the cost factor in the development and application of such systems was also pointed out by a survey carried out in 16 European countries in 1994. Not surprising, the survey showed that small businesses were less likely to invest in food hygiene, safety and quality than larger ones (Gormley, 1995).

Generally, small businesses have the same problems in applying a food safety / quality system, as there is lack of financial resources, knowledge and expertise and often, time. Another factor is the different priorities which smaller businesses have which, in most cases, are connected with cash flow.

However, the percentage of the medium-sized businesses applying a suitable system to ensure the production of safe food rose up to 46% and for the large businesses it was even bigger reaching the 75%. This means that larger businesses were more likely to have a food safety / quality system in place.

(b) Risk categories of the enterprises of the food industry and applied food safety / quality systems

The results clearly showed that respondents were not fully aware of the risks involved in their type of industry and the categorization of their business in relation to these risks.

As regards the results derived from the current cross-tabulation, it was expected that more high-risk enterprises of the food industry would apply a food safety and or quality system and vice versa. However, this was not the case as these results did not show a positive or a negative correlation between the risk category of the industry and the food safety / quality system applied in the enterprises of the food industry.

Half of the low and high-risk industries followed the “common sense” approach for ensuring the safety and quality of their products. This would have been expected only for the low-risk industries where food products are less vulnerable due to their characteristics. However, the same attitude was observed for the high-risk enterprises of food industry. It showed that respondents lacked the necessary expertise to recognize hazards in their production and therefore apply a food safety / quality system.

In-house designed hygiene systems were used in a higher percentage in medium-risk than in low and high-risk types of the food industry. ISO (the ISO 9000 series) was applied in a higher number of low and medium-risk types of the food industry than high-risk ones.

In contrast to the above, the application of Good Manufacturing Practices was positively associated with the risk types of the food industry by respondents. Thus, a higher percentage of high-risk type of the food industry apply Good Manufacturing Practices than medium-risk ones and a higher percentage of medium-risk industrial establishments apply Good Manufacturing Practices than do low-risk ones.

(c) "High level" and "Not a hazard" responses and respondents' level of education

Food hygiene / safety field is a very specialised field of expertise but general education helps food handlers to follow the correct attitude when handling food.

Some surveys found a positive correlation between the level of education and the "high level" responses for microbiological and physical hazards. A survey carried out in Canada in 1989 (Gunningham, 1993), revealed that the level of general education of the operator had a direct effect on the responses of the food handling questions. However, in the present survey and in the case of chemical hazards, it was found that the level of education of the respondents did not have a significant effect on their appreciation of level of hazards.

As regards the "not a hazard" responses, the correlation is the same as the "high level" responses on the microbiological hazards which means that less College and

University graduates than the non- graduates characterised the listed hazards as not hazardous to public health.

An average of 27.4% of College and 19.5% of University graduates considered the microbiological and physical hazards respectively as "high level" hazards. The percentages though are quite low. The figures also support the results and comments made on the results of Question 8 (see Chapter 4.1.6) where the correct ranking of hazards by respondents represents a low percentage indicating the lack of knowledge.

Less than 20% of respondents without a higher education or degree / diploma considered microbiological hazards as "high level" whereas this figure for physical hazards dropped down to 15%. The fact that these percentages were lower than the College / University graduates shows that the higher the level of general education, the higher the level of appreciation of the microbiological and physical hazards.

As regards the "Not a hazard" responses, the lower the level of education, the higher the percentage of respondents who deemed the hazards as not hazardous. This was true for all three categories. However, in general, the lack of specific knowledge was prominent with three-fifth of respondents not appreciating the importance of the listed hazards within their business.

(d) Existence of hygiene practices and risk categories of the enterprises of food industry

The results of this cross-tabulation indicated that the first three practices (i.e. cleaning schedules for the premises and the equipment, inspection of raw materials and temperature monitoring of food) were carried out by almost all food types of food industry.

In the case of microbiological testing of food, it is clear that this was not a common practice among food industry (see Chapter 4.1.7). It is of particular importance that more high-risk enterprises of the food industry carry out this practice, followed by the low-risk and medium-risk ones. However, in any case, the percentage of types of food industry which carried out this practice was very low. What should be noted here is that the frequency of microbiological testing is substantial. Thus, the results of this practice can give the actual microbiological characteristics of the products produced.

These results supported the discussion in Chapter 4.1.6 where respondents did not rank correctly the listed hazards. The same tendency was observed in another study carried out in UK where respondents did not assess correctly what risk to food safety, their business represented (Mortlock *et al*, 1999).

(e) Size of business and the existence of hygiene practices

The results of this cross-tabulation indicated a positive correlation between the size of business and the existence of the listed hygiene practices. Businesses employing more food handlers were much more likely (steady increase of the percentage) to have these practices in place. This also showed that larger businesses were more aware of the importance of these practices.

This tendency was the same as in the case of the application of food safety / hygiene systems based on the size of the businesses (see cross-tabulation of size of business and the application of food safety / hygiene system) where the size of the business played a significant role in the application of such a system or not.

4.2.9 The HACCP system

The HACCP system was known by only 55% of the respondents. However this figure is high compared with the results of similar surveys carried out in UK where only 41% and 42% had heard about the HACCP system (Ehiri *et al*, 1997a; Walker *et al*, 2003). Another survey carried out in Ireland in 2000 revealed that 46% of respondents knew about the HACCP system (Food Safety Authority of Ireland, 2001). It should be noted that at the time of the conduction of the present survey, the implementation of the HACCP system by Cyprus businesses was not a legal requirement, whereas in UK and Ireland it was. It is assumed that more respondents would probably have known about the HACCP system if the system was legally required in Cyprus.

The sources from which respondents obtained their information about the HACCP system are very predictable. Ideally, every food business should have access to a variety of information sources, including research databases.

Public Health Inspectors and external consultants took the lead for communicating information / knowledge to food businesses about the HACCP system. However, it was not possible to assess if this information was sufficient and helped in understanding the system. In the survey carried out in Ireland in 2000, 62% of respondents answered that they have heard about the HACCP system from the Environmental Health Officers / Health Boards (Food Safety Authority of Ireland, 2001). Similar results were revealed by a survey carried out in UK in which 68% of the managers of the surveyed businesses had acquired information on the HACCP system from their local Environmental Health Officers (Walker *et al*, 2003).

Implementation of the HACCP system by all food businesses is legally mandatory in Cyprus as from 6th of April 2002 (Official Gazette of the Republic of Cyprus, 2002). Public Health Inspectors were the most important source of information about the HACCP system during their visits to food businesses. However, and as noted earlier in this Chapter, implementation of the HACCP system was not legally mandatory at the time of conduct of this survey.

External consultants provided information, either after calling or by invitation as a result of their efforts to advertise / promote their services. The results of the survey show that more than half of the respondents received knowledge regarding the HACCP system by external consultants, which is a significantly higher percentage than that of the survey, carried out in UK (Panisello *et al*, 1999).

Another source of information is training courses provided by Colleges and Universities. This means that respondents received information on the HACCP system at a College (founded either in Cyprus or abroad) or at a University (abroad) usually on a short course, in Departments associated with food hygiene, safety and quality. The information provided by these sources depends on the duration the level of education. In the current survey, almost one third received knowledge about the HACCP system in such way. The results of similar studies which were carried out in UK and Ireland showed that 37% and 15% of respondents respectively received this knowledge from Colleges and Universities (Panisello *et al*, 1999; Food Safety Authority of Ireland, 2001).

Seminars organized by the Cypriot Government or external consultants can provide valuable information to food businesses about food hygiene and safety and, indeed, about the HACCP system. One fifth of respondents obtained knowledge regarding the system by attending seminars. This figure is quite high because, in combination with other sources of information, more people from the management and food handlers received the information about the system. The advantage of these seminars is that the trainer has the flexibility to provide specific information on something which considers as of more importance based on the kind of the business (e.g. hotel, restaurant / take away, food industry). However, as the businesses may be required to pay for those seminars organized and delivered by external consultants, the management of some businesses may be reluctant to organize such seminars. In the survey carried out by the Food Safety Authority of Ireland (2001) revealed that seminars conducted by the Environmental Health Inspectors were the second most important source of information with 23% positive answers.

As regards the Internet, the general problem is that it is not accessible by all people working in food businesses. This is the reason of the low percentage of respondents who claimed that they received information on the system when using the Internet.

The implementation of the HACCP system is the target of food regulatory authority in every country and of course the same happens in the case of Cyprus. This survey showed that the implementation level of the HACCP system was 17%. In contrast the percentages of the HACCP system implementation in UK in three surveys carried out from 1995 to 1998 were 23, 72.6 and 38.2 respectively (Ehiri *et al*, 1997a; Panisello *et al*, 1999 and Mortlock *et al*, 1999). From the survey carried out in Ireland in 2000 by the Food Safety Authority it was revealed that the implementation level of a food safety management system applicable to food businesses was 74% of the surveyed businesses (Food Safety Authority of Ireland, 2001).

As regards the implementation of the HACCP system among the three categories, it was clear that more hotels and industries implemented it than catering businesses. The results of the three surveys carried out in UK showed a variation in implementation. In particular, Mortlock *et al* (1999) found out that 15.6% of catering businesses and 92% of industrial enterprises applied the HACCP system. Panisello *et al* (1999) revealed that 37% of catering businesses and hotels and 50% of food industry implemented the System. Finally, the implementation rates for catering businesses and food industry in the survey in Glasgow carried out by Ehiri *et al* (1997a) were 4% and 56% respectively. Typically, catering businesses are the least prepared to take steps necessary for implementation.

There was a wide range of percentages and it is clear that the geographical region and the time of the survey influenced the results. However, in the case of Cyprus, the implementation levels were lower than in other European countries, especially UK and Ireland.

As the HACCP system was not a legal requirement at the time of the survey, the businesses implemented the System for other than legal reasons. These reasons are analyzed and discussed later.

The first two businesses (a bakery and a meat factory) implemented the HACCP system in 1996 and their number steadily increased in the following years. It is clear that these businesses were farsighted and were following the EU legislation framework, which would later become part of the Cyprus legislation framework.

The results of a survey carried out in the UK dairy sector in 1998 revealed that only 7% of the total number of businesses had the System in place before it became legally mandatory (Henson & Holt, 1998). Afterwards, the implementation rate of the HACCP system steadily increased.

It is very important that the team responsible to develop and implement the HACCP system has the in-depth knowledge. Thus, in many cases, the aid of external resources (i.e. officers from the government and external consultants) is sought.

According to the present survey, external consultants played the most important role in the development and implementation of the HACCP system as more than 75% of businesses asked them to provide their assistance. External consultants in Cyprus work privately, usually on their own.

There are a number of external consultants (probably less than 20) providing their services to food businesses in food safety / hygiene matters but they are not liable by any Law to be registered by any governmental body or to have a licence to exercise this occupation (Anthousis Sofoclis 2002, personal communication). Their qualifications vary and they may be food technologists, microbiologists or others. Thus, it is down to the food business to select the most appropriate and qualified consultant to develop the HACCP system. Under such circumstances, this is a "hit and miss" situation.

Officers from the government were not a vital source of help for businesses developing and implementing the system as they represent the least percentage among the three sources of assistance. The officers can only provide general guidelines for the HACCP system and the requirements set by existing legislation. Governmental departments are responsible for the inspection of each food businesses and auditing of those businesses applying the system, thus they cannot offer their help beyond a certain point.

The purpose of every food hygiene / safety system is to offer to the consumers safe food products. The HACCP system goes a long way to fulfill these requirements. In this survey, almost all respondents from the businesses in which the System was applied cited the increase of the safety of their products as the most important reason for its implementation. Panisello *et al* (1999) found out that half of the respondents from the businesses having the HACCP system in place implemented it for the above reason. However, Henson and Holt (2001) in their survey, which covered the UK dairy sector, revealed that this reason came after the legal requirement and customer pressure.

The second important reason is to give commercial advantage to their products. Of course, commercial advantage also stems from the first reason because any food business with successful food safety system produces safe food and, therefore, has an advantage over its competitors.

In many cases businesses proceed to major changes in their production line in response to customers' pressure. Changes in larger businesses are largely customer driven, however, this has little impact on smaller operations, many of whose customers are the end-user (Taylor, 2001). Customers may represent another food business or the consumers themselves. Both parties are capable to persuade food businesses to make such changes in order to increase the hygiene / safety or even quality of their products because of the economic factor involved. Customers' pressure is the second most important factor – 37.5% - for businesses to apply the HACCP system in UK as the survey carried out by Panisello *et al* revealed (1999). Cyprus Consumers Association was formed in 1973 and it is progressively educating consumers about their rights. The association carries out food studies about hazards, such as lead in vegetables (Papastephanou, 2002).

The World Health Organization has identified that market forces can force a business to implement the HACCP system because the business can gain access to domestic and foreign markets and satisfy the customer's demand (WHO, 1999). Furthermore, Lee and Hathaway (1999) concluded that food-exporting countries are forced by the market to have a HACCP system in place in order to effectively assure the safety of food in international trade and meet the market access requirements of an increasing number of importing countries.

Customer pressure was the second most important reason identified in the current survey for developing and implementing the HACCP system in hotels. The tourist industry and, therefore, hotel industry is a very important source of income for the economy of Cyprus. In 1996, the contribution of the hotel industry and restaurants to Gross Domestic Product of the country was 8.5% (Statistical Service of the Republic of Cyprus, 1997). Almost 10% of the total economically active population is employed in this sector. Furthermore, a total number of 2.7 millions of tourists visited Cyprus in 2001 (Statistical Service of the Republic of Cyprus, 2001). In order to provide adequate assurance to the tour operators about the safety of hotel food a reliable system such as HACCP has to be in place. Many tour operators insist that hotels implement the HACCP system before cooperating with them.

The number of tour operators who follow this practice has increased year by year. This practice can be very helpful for the hotel industry. In addition, the reputation of Cyprus abroad can be enhanced.

The least important factor for implementing the HACCP system was found to be the impending legal requirement. The ideal scenario is that businesses are informed about the importance and advantages of the HACCP system rather than forcing them to implement it. However, this does not happen in the majority of cases and, therefore, the compliance required by the law is necessary (Bernard, 1998). In this survey, as the HACCP system was not legally required, the wording was "Due to impending legal requirement". Shortly after the completion of the survey, the Regulations making the HACCP system legally mandatory was passed by the House of Parliament (Official Gazette of the Republic of Cyprus, 2002). These Regulations (as noted earlier in Chapter 2.2.6) came into force on 6th of April 2002.

The continued auditing and verification of a HACCP system demands more attention than the initial development of a HACCP plan (Sperber, 1998). For that reason, each Government and other accredited bodies should audit the HACCP system in all food businesses and provide a certificate that the System works efficiently and the target is accomplished that is the production of safe food.

Audit of the HACCP system in a food business is very important for the regulatory authority because much valuable information can be obtained. This information can be used to support and promote the wider conduction of the HACCP-based inspection rather than a sanitation-based inspection. The conduct of the audit is based firstly on the scientific / technical information arising from the published literature and secondly on the professional expertise of the auditors.

Almost 60% of businesses applying HACCP were externally audited (see Table 4.55). These audits were conducted either by governmental officials, external consultants or other auditing bodies like ELOT (Hellenic Organisation for Standardization). Officers from the Cyprus Government have the right to check the HACCP system during any visit to these businesses. However, in the past as they were not legally bound to carry them out.

The auditing carried out by International Agencies referred only to international businesses such as Holiday Inn, Hilton International, Mc Donald's and, therefore, the auditors are set by the Head Offices of these businesses. International organizations mostly audit hotels and catering businesses and not industries.

On the other hand, private consultant / auditors are involved in auditing different types of food industry rather than hotels and catering businesses. In almost all cases, the same private consultants / auditors were responsible for the development of the HACCP plan and the application of the system.

A survey carried out in the UK dairy sector in 1998 revealed that 93% of the businesses that fully implemented the HACCP system were externally audited (Henson & Holt, 2000).

The advantages of assessing the HACCP system by the regulatory authorities (Kvenberg *et al*, 2000) are:

(a) The collection and analysis of information about the implementation of the HACCP system in order to improve:
    i) The implementation process in other businesses and

ii) The audit procedure and

(b) The use of resources in a more effective manner. Audit can determine possible deficiencies of the HACCP system applied in a food business. Thus, the improvement of these deficiencies can save resources (e.g. money, time, expertise) and sustain and extend the annual turnover and much of the time the reputation of the business.

In Cyprus, Government officials should play a role in educating people from food businesses about the HACCP system. Such officers should not be the "enforcers" but providers of information and help in any food hygiene / safety field on the HACCP system as its development and implementation is a difficult process.

In the same sense, if the Ministry of Health publishes information / guidelines on the HACCP system, it will promote a wider awareness of it among the interested people and businesses.

The establishment of a HACCP board under the Government auspices could be very beneficial but respondents did not consider it as a major source of help. The reason for that is the very little help provided by Government Officers in the past as indicated by the results of Question 16 where only 9.6% of businesses applying the HACCP system, develop it with the aid of the Government.

On the other hand, private consultants were the second most important source of information that helped businesses to learn more about the System.

Respondents were of the opinion that the use of the Internet to seek information on the HACCP system was of limited importance to them. Unfortunately there are still problems in attaining a broad access to the Internet by food businesses in Cyprus. There are also problems in finding the specific Internet sites offering information on the HACCP system.

4.2.10 Cross-tabulations

(a) Size and number of businesses applying the HACCP system

As expected, the level of implementation of the HACCP system was positively correlated with the size of food businesses. The results of this cross-tabulation clearly showed that as the number of food handlers increased in a business, the chances of this business of applying the system also increased. These findings are similar to these of a survey carried out in UK in 1999 (Mortlock *et al*). The survey showed that small enterprises of food industry were significantly less likely than their larger competitors to implement the HACCP system. Panisello *et al* (1999) in their survey revealed that businesses belonging to categories of 50 or less food handlers were less likely to implement the HACCP system than larger ones.

The reasons for the low level of the HACCP system implementation among small food businesses are may be firstly the lack of knowledge, expertise and experience (Panisello & Quantick, 2001) and secondly the lack of appropriate resources such as time, manpower and management commitment to obtain this knowledge (Panisello *et al*, 1999). Both are due to insufficient understanding of the functions of the HACCP principles and how it can be implemented. Small businesses in Cyprus, tend to think in terms of productivity rather than safety and regard the system as complicated, this is also the case elsewhere (Panisello & Quantick, 2001).

Larger food businesses can also invest resources in training for successful implementation of the HACCP system, whereas smaller businesses may have other priorities. The latter was confirmed by another survey, which covered 809 small and medium businesses throughout European countries. The results of this survey showed that small businesses were less likely to invest in hygiene and food safety than larger ones (Gormley, 1995). Therefore, small businesses may prefer to invest in other areas to improve quality or quantity rather than the safety of foodstuffs (Forsythe & Hayes, 1998).

(b) Years of operation and number of businesses applying the HACCP system

There was a direct effect of the years of operation of the businesses and the implementation level of the HACCP system. The percentage of businesses which had the system in place and operating for up to 15 years decreased as the years of operation increased. So, there is a "negative" correlation of the years of operation and the implementation of the HACCP system. This can be explained by the fact that new businesses (operating up to 5 years) are more likely to use more sophisticated methods of work. Furthermore, a food safety system like HACCP, is easier to develop at the same time as the business is built up and therefore, when the business starts its operation, the HACCP system will be in place.

On the other hand, well-established (over 16 years of operation) were again more likely to have the HACCP system in place. Because their many years of being established on the island, their management appears to have understood the need to move according to new trends in food safety control. These companies usually are family-run businesses where the offspring eventually take over the businesses. Typically, the younger generation of owners is better educated and more modern in their approach to the business. In the same sense, the experience gained by owners throughout the years of operation may have helped in the better understanding of the necessary changes.

(c) Correlation of information of the HACCP system and size of food businesses

The results presented in Table 4.59 clearly show that there is a positive correlation between the size of the businesses and a better appreciation of what the HACCP system is. Thus, the respondents from businesses employing more food handlers are more likely to select a valid answer. On the other hand, there is a negative correlation between the size of the businesses and the "Do not know" response.

The above tendency was evident in the fact that the size of the business plays vital role in the knowledge of food hygiene and safety matters and, specifically, of the

HACCP system. The reasons for that are the same as similar to those given in Chapter 4.2.9.

(d) Risk categories of businesses and level of implementation of the HACCP system

The results of this cross-tabulation did not show a correlation between the risk category of food business and the level of implementation of the HACCP system. It was expected that more high-risk businesses would implement the HACCP system than medium-risk businesses. However, this was not the case as more medium-risk businesses implemented the system than high-risk.

The break down of the high-risk businesses into their components i.e. high-risk industries, catering businesses and hotels shows that hotels implemented the System to a greater extent than the other two, following by enterprises of the food industry and catering businesses.

4.2.11 Reasons for not having the HACCP system in place

The reasons given by respondents for not implementing the HACCP system until now illustrate the general attitude in the country before accession to the EU.

The reasons "it is not required" and "nobody knows about it" were selected by 11.2% and 3.4% of respondents respectively. These percentages, however, were not very high. These respondents of the Cyprus survey were totally unaware either of the HACCP system itself or its benefits, or the forthcoming legal obligation for the development and implementation of the HACCP system (at the time the survey was conducted). Another reason for this attitude is the weak market-based incentives which is a negative factor for the adoption of the HACCP system (Henson & Holt, 2001).

Panisello *et al* (1999) revealed that 54.5% and 45.5% of respondents from the businesses that did not have the System in place gave the reason "it is not required" and "nobody knows about it" respectively, which are higher percentages compared to the results of the survey carried out in Cyprus. The Food Safety Authority of Ireland in its survey carried out in 2000, revealed that 46% of respondents answered that one reason for not implementing the HACCP system was that they did not know about it (Food Safety Authority of Ireland, 2001).

The reason "it is not a legal requirement" was an easy way in the past to avoid giving the real reason for not implementing the HACCP system as this answer did not indicate whether it was unwillingness or lack of resources.

Economic constraints can be a practical barrier to implementing the HACCP system. These constraints could mean that the provision of the assistance by government or industry / trade association or the capacity of the business itself to implement the HACCP system is considerably reduced (WHO, 1999; Codex Alimentarius, 1999).

Respondents did not understand that long-term savings that could accrue to the industry budget. These saving could be the following (Codex Alimentarius, 1999):

(a) Reduced litigation due to reduced food safety failures

(b) Reduced spoilage due to improved handling, storage and processing of food and

(c) Reduced labour disputes due to improved management/staff commitment.

The costs of the development and implementation of the HACCP system was an important factor for respondents not to develop the System. It is worrying that 76.9% of respondents of this question are of the opinion that the development and implementation of the system would cost more than 17,001 Euros.

All respondents from catering businesses however, believed that the system would cost less than 17000Euros. The possible reason for this estimate is the size of their businesses and the low turnover.

On the other hand, respondents from hotels believed that the cost the HACCP development and implementation was more than 51,001 Euros. In addition, one respondent gave the extraordinary estimate of 340,000 Euros.

In the case of enterprises of the food industry, respondents gave a wide range of prices, the highest of which was 8500 Euros.

In the Ireland survey, only 6% of respondents considered the cost as a barrier in implementing the HACCP system (Food Safety of Ireland, 2001).

It looks as though the prices of development and implementation of the system were mainly set by the external consultants. In Cyprus their number does not exceed 15-20, so the higher prices are probably set by them.

4.2.12 Development and implementation of the HACCP system

As presented in Table 4.63, a percentage of respondents as high as 51.7% claimed that they would develop and implement the system only if it would become legally mandatory. Therefore, it can be assumed that by they end of 2003, all these businesses will develop and implement the HACCP system. This is a very optimistic assumption taking into account other surveys carried out in UK five or more years after the HACCP system became a legal requirement led implementation levels of between 23-38.5% (Ehiri *et al*, 1997a; Mortlock *et al*, 1999). Although Panisello *et al* (2001), in their survey revealed that the implementation level of the HACCP system was 72.6% but that some high-risk businesses did not apply the HACCP system.

As a result of the above, it can be assumed with some certainty that the HACCP system implementation level by the end of 2003 will be less than 50%.

5 CRETE STUDY: RESULTS AND DISCUSSION

Crete has been chosen for this study for the following reasons:

(a) The similarities in the tourist industry and the same number of tourists visiting Cyprus and Crete (2.000.000-2.500.000),

(b) The Greek language of the population,

(c) Many Cypriot international companies (hotels) operate in Crete such as Louis Hotels,

(d) The similar education system in mainland Greece and in Crete as well,

(e) The Laboratory of Clinical Bacteriology, Parasitology, Zoonoses and Geographical Medicine, Unit of Food, Water and Environmental Microbiology, Medical School, University of Crete (WHO Collaborative Centre) established on the island and

(f) The expectation that Crete food businesses would be better informed about the HACCP system.

5.1 Results of the Crete study

The study covered a total number of 50 food businesses, which represents the 2.7% of the total number of food businesses of Heraklion County in Crete. They are divided into 3 categories: industry, catering businesses and hotels with restaurants and B/B accommodation. Catering businesses include restaurants, taverns, pizzas and take aways.

5.1.1 General information

5.1.1.1 Age, position in business and level of education of respondents

Almost two-thirds (62%) of the respondents were between 30-49 years old. The distribution of respondents' ages in the specified age categories is found in Table 5.1.

Table 5.1: Distribution of respondents' ages

	Frequency	%
20-29 years old	13	26
30-39 years old	17	34
40-49 years old	14	28
50-59 years old	6	12

Almost 85% of the respondents from hotels were the chefs and production line supervisors. In catering businesses the owners constitute the great majority whereas half of the respondents from industries are production line supervisors. In the following table (Table 5.2), the frequencies and the percentages of the respondents' position in the businesses are found.

Table 5.2: Respondents' position in the business

Position in the business	Frequency			
	Hotel (%)	Catering (%)	Industry (%)	Total (%)
Owner	0 (0)	11 (73.3)	3 (18.7)	14 (28)
Manager	1 (5.3)	2 (13.3)	1 (6.2)	4 (8)
Chef	8 (42.1)	1 (6.7)	0 (0)	9 (18)
Production line supervisor	8 (42.1)	1 (6.7)	8 (50)	17 (34)
Food technologist	0 (0)	0 (0)	3 (18.7)	3 (6)
Quality control supervisor	2 (10.5)	0 (0)	1 (6.2)	3 (6)

The education system in Greece (and in Crete as well) has the same structure as in Cyprus. In Table 5.3, the respondents' level of education is presented.

Table 5.3: Level of education of respondents

	Frequency	%
Number of respondents with Lyceum Leaving Certificate	19	38
Diploma	22	44
BSc/BA	6	12
MSc/MA/MBA	3	6
Total number of respondents with College and University degree	31	62

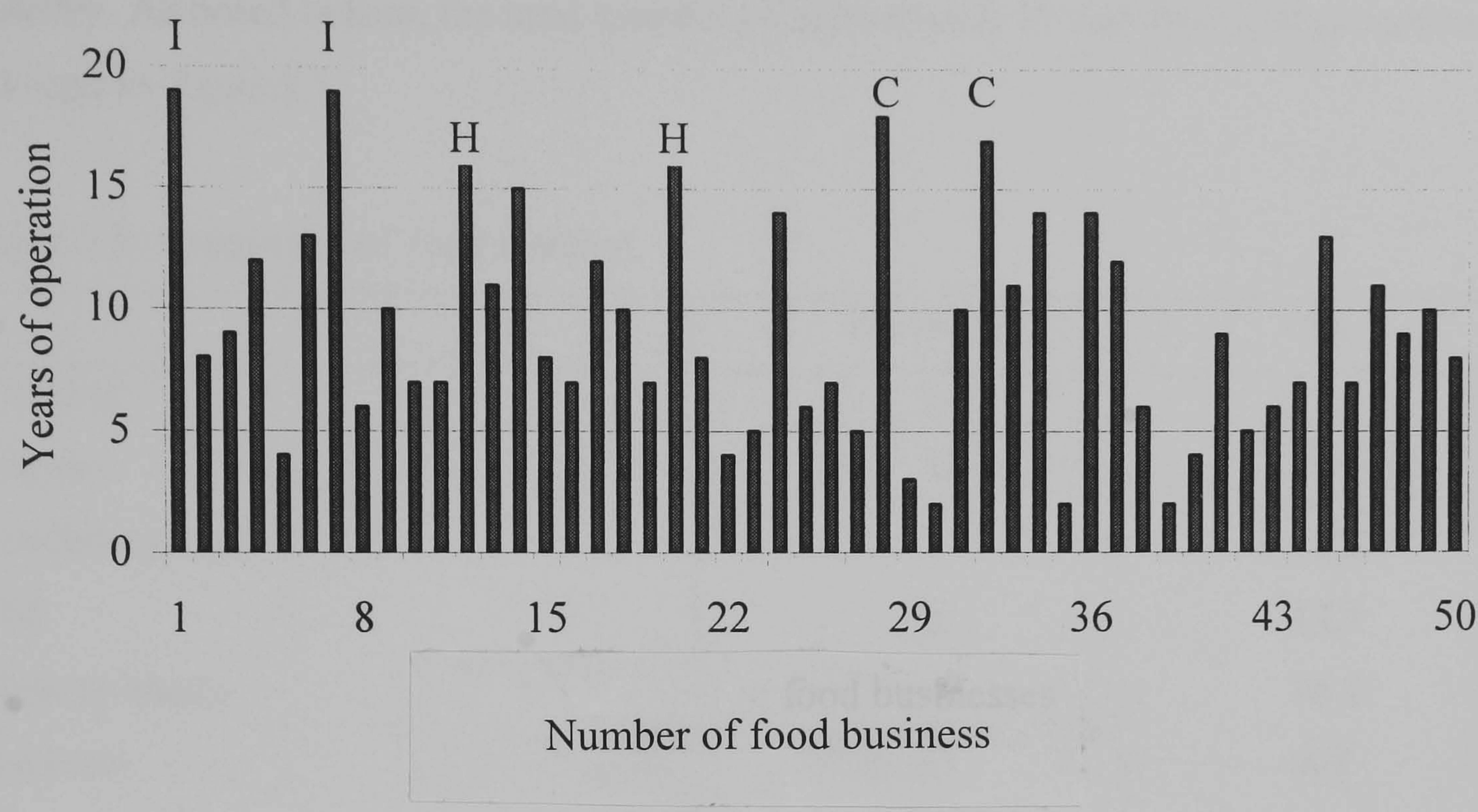
5.1.1.2 Type and duration of food businesses

The mean numbers of years of operation of each category of food business are 7.9, 8.3 and 11 years for hotels, catering businesses and industry businesses respectively. In Table 5.4, the mean numbers of years of operation of each category of food businesses are presented. In Chart 5.1, the years of operation for each food business are presented.

Table 5.4: Mean numbers of years of operation of each category of food business

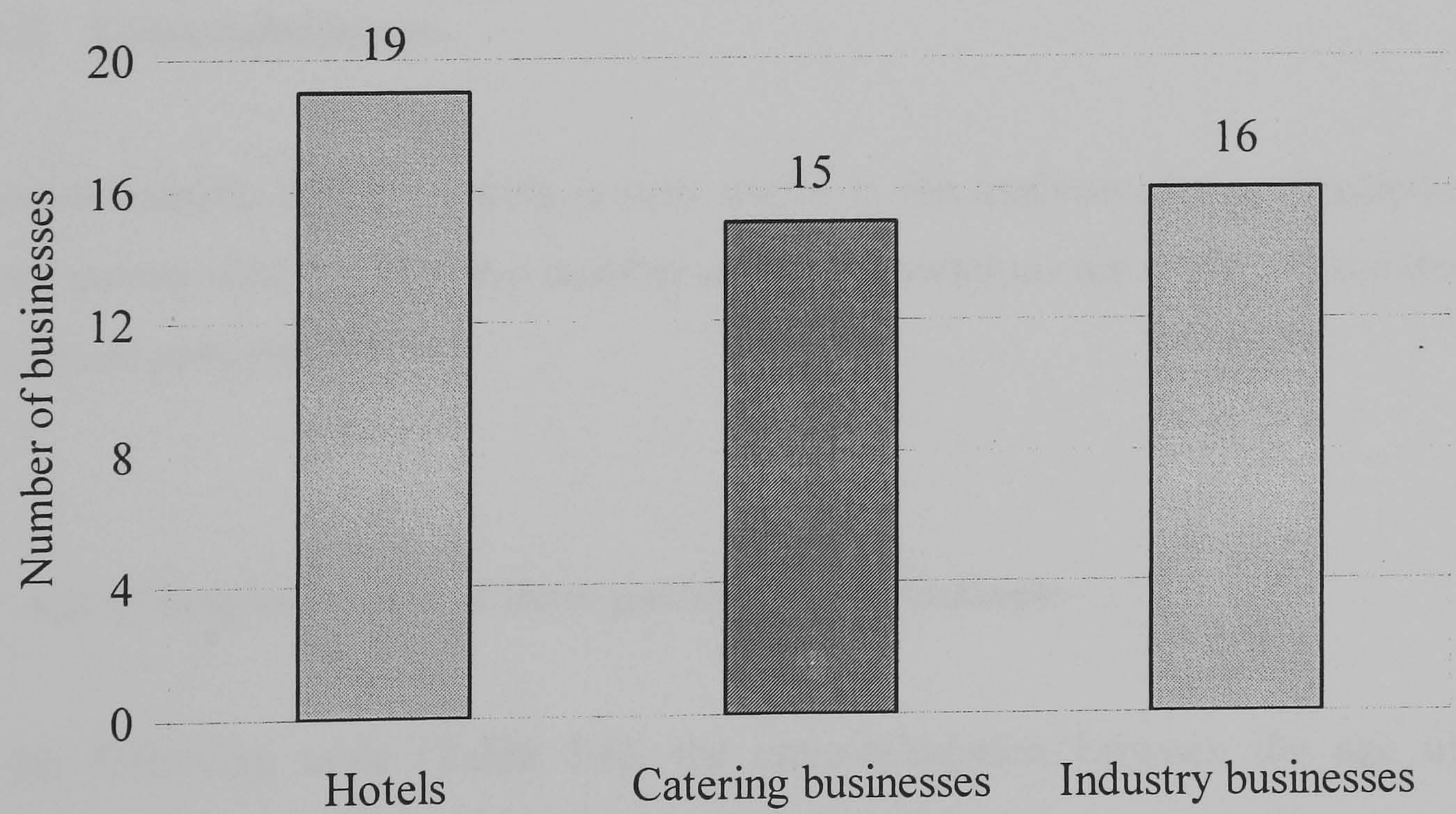
Kind of business	Mean number of years of operation
Hotel	7.9
Catering	8.3
Industry	11

Chart 5.1: Years of operation of food businesses



Thirty-eight (38%) of the surveyed businesses are hotels, 15 (30%) are catering businesses and the remaining 16 (32%) are industry businesses. These results are presented in Chart 5.2.

Chart 5.2: Number of surveyed businesses of each category



This question was addressed only to the respondents from enterprises of food industry. As noted before, the total number of industries is 16 and their categorisation is found in Table 5.5.

Table 5.5: Categories of food industry

	Frequency	%
Catering	2	12.5
Various	3	18.7
Confectioneries	2	12.5
Fish	2	12.5
Meat products	3	18.7
Bakeries	1	6.2
Dairies	1	6.2
Ice cream	2	12.5

All above enterprises are characterised as high-risk ones based on the same principles as described in Chapter 4.1.2.

5.1.2 Cross-tabulations

Cross-tabulation of the answers is very useful in the analysis of this questionnaire-based survey. For this reason a number of cross-tabulations are made and the derived results are presented.

(a) Age of respondents and their position in the business

In the following table (Table 5.6), the cross-tabulation between the age of the respondents and their position in the business is found.

Table 5.6: Cross-tabulation of the respondents' position in the business and their age

Position in the business	Age											
	20-29 years old			30-39 years old			40-49 years old			50-59 years old		
	H	C	I	H	C	I	H	C	I	H	C	I
Owner	0	4	0	0	4	0	0	3	0	0	0	3
Manager	0	0	1	0	2	0	1	0	0	0	0	0
Chef	0	0	0	4	1	0	1	0	0	3	0	0
Production line supervisor	1	0	2	3	0	3	4	1	3	0	0	0
Food technologist	0	0	2	0	0	0	0	0	1	0	0	0
Quality control supervisor	2	0	1	0	0	0	0	0	0	0	0	0

(b) Age of respondents and kind of food business

Most respondents from hotels and catering businesses are between 30-39 years old, whereas from the industry sector between 20-29 years old. In the following table (Table 5.7), all the results are found with the percentages of each age group.

Table 5.7: Cross-tabulation of the respondents' age and the kind of the food business

Age	Kind of business					
	Hotel	(%)	Catering	(%)	Industry	(%)
20-29 years old	3	(15.8)	5	(33.3)	6	(37.5)
30-39 years old	7	(36.8)	6	(40)	3	(18.7)
40-49 years old	6	(31.6)	4	(26.7)	4	(25)
50-59 years old	3	(15.8)	0	(0)	3	(18.7)

(c) Age of respondents and their level of education

More than half of the respondents between the ages of 20-49 have obtained a Diploma or a University Degree. However, respondents older than 40 years old are less qualified as 66.7% have not possessed a Diploma or a University degree. In Table 5.8, all the results from this cross-tabulation are presented.

Table 5.8: Cross-tabulation of the respondents' level of education and their age

Level of education	Age			
	20-29 years old	30-39 years old	40-49 years old	50-59 years old
Lyceum leaving certificate	4	5	6	4
Subtotal	4 (28.6%)	5 (31.2%)	6 (42.7%)	4 (66.7%)
Diploma	5	10	5	2
BSc/BA	3	1	2	0
MSc/MA/MBA	2	0	1	0
Subtotal	10 (71.4%)	11 (68.7%)	8 (57.3%)	2 (33.3%)

(d) Position of respondents in the business and their level of education

Thirteen (92.9%) of the owners have not obtained College or University degree. This percentage decreases down to 50%, 28.6% and 11.8% for managers, chefs and production line supervisors respectively. In Table 5.9 all the results are presented.

Table 5.9: Cross-tabulation of respondents' position in the business and their level of education

Position in the business	Level of education				
	Lyceum Leaving Certificate (%)	Diploma	BSc/BA	MSc/ MBA	(%) *
Owner	13 (92.9)	1	0	0	1 (7.1)
Manager	2 (50)	1	1	0	2 (50)
Chef	2 (28.6)	7	0	0	7 (71.4)
Production Line Supervisor	2 (11.8)	13	2	0	15 (88.2)
Food Technologist	0 (0)	0	1	2	3 (100)
Quality Control Supervisor	0 (0)	0	2	1	3 (100)

*: Total number of respondents with Diploma or University degree.

(e) Level of education of respondents and the kind of business

College Diploma is the most frequent level of education acquired among the respondents from hotels and industries whereas the Lyceum Leaving Certificate is more common for catering businesses. All results from this cross-tabulation are presented in Table 5.10.

Table 5.10: Cross-tabulation of the level of education of respondents in relation to the kind of business

Level of education	Hotel	Catering	Industry
Number of respondents with only Lyceum Leaving Certificate	3	13	3
Diploma	13	2	7
BSc/BA	3	0	3
MSc/MA/MBA	0	0	3
Number of respondents with Diploma or University degree	16	2	13

5.1.3 Nature of business and mode of operation

As shown in Table 5.11, meat and meat products are the most widely used products. It is identified by 82% of the respondents. Percentages exceed 100 because multiple answers were given by respondents.

Potatoes (chips) and fruits and vegetables were not selected by respondents from hotels and catering businesses because meals are almost always accompanied by them.

Kind of products such as wine and other alcoholic drinks and water are less selected due to the fact that respondents from hotels and catering businesses do not use them as raw material but they present them to consumer without any processing.

The division of products into high, medium and low-risk is the same as the division made and presented in Table 4.15 in Chapter 4.1.4.

Table 5.11: Kind of products handled in all businesses

Kind of products	Frequency	%
Meat and meat products	41	82
Poultry and poultry products	38	76
Milk and milk products	26	52
Fish and fish products	33	66
Rice and rice products	29	58
Bakery and confectionery products	29	58
Drinks and juices	28	56
Potatoes (Chips)	1	2
Wine and other alcoholic drinks	1	2
Water	1	2
Fruits and vegetables	1	2

The chilling / freezing processes are employed by 24% of industries whereas the roasting, frying and boiling processes by 20%. All results are presented in Table 5.12. Percentages exceed 100 because multiple answers were given by businesses.

The categorisation of processes into high and medium-risk is the same as the one presented in Section 4.1.4 and in Table 4.17.

Table 5.12: Processes employed by industries

Processes	(Risk)	Frequency	%
Canning	(High)	2	4
Chilling / Freezing	(High)	12	24
Drying	(Medium)	3	6
Roasting / Frying / Boiling	(High)	10	20
Baking	(High)	3	6
Pasteurisation	(High)	1	2
Curing / Salting	(Medium)	5	10
Smoking	(High)	1	2
Maturation	(High)	1	2
UV for water	(Medium)	2	4
Filtration	(Medium)	2	4

For parity, the same business classification as for Cyprus survey was used. The categorisation of businesses is based on the same principles used for the categorisation of the surveyed businesses in Cyprus. All the results are found in Table 5.13. In Table 5.14, the total number of food handlers is found. In Table 5.16, the mean numbers of food handlers for the three categories of businesses are presented.

Table 5.13: Categorisation of food businesses

Category	Number of businesses				
	Hotels	Catering businesses	Industries	Total	(%)
<u>A. Small businesses</u>					
1-2 food handlers	0	1	0	1	2
3-4 food handlers	0	7	0	7	14
5-10 food handlers	4	7	3	14	28
Subtotal	4 (21%)	15 (100%)	3 (18.7%)	22	44
<u>B. Medium businesses</u>					
11-50 food handlers	14 (73.7%)	0 (0%)	12 (75%)	26	52
<u>C. Large businesses</u>					
More than 51 food handlers	1 (5.3)	0 (0%)	1 (6.2%)	2	4

Table 5.14: Number of full time food handlers

Category	Number of food handlers				
	Hotels	Catering businesses	Industries	Total	(%)
<u>A. Small businesses</u>					
1-2 food handlers	0	2	0	2	0.2
3-4 food handlers	0	24	0	24	2.4
5-10 food handlers	37	53	28	118	12
Subtotal	37	79	28	144	14.6
<u>B. Medium businesses</u>					
11-50 food handlers	314	0	373	687	69.7
<u>C. Large businesses</u>					
More than 51 food handlers	100	0	54	154	15.6
Total	451	79	455	985	100

Table 5.15: Mean number of food handlers for the three categories of businesses

	Total number of businesses surveyed	Total number of food handlers	Mean number
Hotels	19	451	23.7
Catering businesses	15	79	5.3
Industries	16	455	28.4

A Health Certificate in Greece is a certificate issued to food handlers by the Public Health Services working in food businesses. The Health Certificate is valid for five years from the date of issue after macroscopic examination of the food handlers by a doctor (Official Gazette of the Hellenic Republic, 1992). However, there are cases when such a doctor requires food handlers to undergo further examinations e.g. stool and blood examinations (Official Gazette of the Hellenic Republic, 1992). X-rays and tests for Hepatitis A is carried out in cases where food handlers work in a kindergarten (Kokkinakis Manolis and Kotsaki Filia, 2001, personal communication). However, food handlers working in a food business that implemented the HACCP system are examined for Salmonella and parasites and this is identified during the conduct of the survey.

The total number of full time food handlers with valid Health Certificate is 962 representing the 97.7% of the total number of full time food handlers. The results are presented in Table 5.16.

Table 5.16: Total number of full time food handlers with valid Health Certificate

Total number of full time food handlers	Total number of full time food handlers with valid Health Certificate	%
985	962	97.7

Temporary food handlers work part time and they are employed under the same conditions as the temporary food handlers employed in food businesses in Cyprus.

Nine (18%) out of 50 surveyed businesses employ temporary food handlers and all of them are small businesses. No hotel employs temporary food handlers. On the other hand, there are 5 catering businesses employing 7 temporary food handlers and 4 industries employing 21 temporary food handlers.

The total number of temporary food handlers with valid Health Certificate is 17 which represents the 60.7% of the total number of temporary food handlers. The results are presented in Table 5.17.

Table 5.17: Total number of full time food handlers with valid Health Certificate

Total number of temporary food handlers	Total number of temporary food handlers with valid Health Certificate	%
28	17	60.7

5.1.4 Inspections of the businesses by Public Health Inspectors

Sanitary inspections (see also Chapter 4.1.5) are carried out for the same purposes as in the rest of Greece. In Table 5.18, the frequencies of the inspections carried out by Public Health Inspectors are presented.

Based on the results of Table 5.18, the calculated mean numbers of inspections per year for hotels is 0.3 (every 3 years and 3 months), 1.3 (every 9 months) and 1.2 (every 10 months) for catering businesses and industries respectively.

As noted in Question 5a, Section 5.3, all surveyed industries are high-risk industries. If catering businesses and hotels are added in the high-risk category then all surveyed businesses are high-risk businesses. Thus the mean interval between the inspections carried out in all food businesses is almost 2 years (every 1 year and 7months).

Table 5.18: Frequency of inspections of the food businesses by Public Health Inspectors

Kind of business	Inspections per year				Subtotal number of inspections
	Never	One	Two	Three	
a) Hotels					
Number of premises inspected	14	4	1	0	
Number of inspections	0	4	2	0	6
b) Catering businesses					
Number of premises inspected	2	8	4	1	
Number of inspections	0	8	8	3	19
c) Industries					
Number of premises inspected	6	3	5	2	
Number of inspections	0	3	10	6	19
				Total number of inspections	44

5.1.5 Hazard awareness

Respondents were asked to assess the level of risk to food safety (high, medium, low or no risk), the listed hazards represent (Table 5.19). A relatively low percentage of respondents answered that the listed microbiological, physical and particularly chemical hazards are high-level hazards.

Table 5.19: Ranking of hazards

Hazards	Levels of hazards			
	High (%)	Medium (%)	Low (%)	Not a hazard (%)
A. Microbiological				
Salmonella	17 (34)	12 (24)	20 (40)	1 (2)
Staphylococcus	17 (34)	11 (22)	21 (42)	1 (2)
E. coli	14 (28)	14 (28)	21 (42)	1 (2)
C. jejuni	13 (26)	9 (18)	27 (54)	1 (2)
Clostridium botulinum	5 (10)	15 (30)	25 (50)	5 (10)
Spoilage organisms	2 (4)	15 (30)	28 (56)	5 (10)
Mean	11.3 (22.7)	12.7 (25.4)	23.7 (47.4)	2.3 (4.7)

... continued

Hazards	Levels of hazards			
	High (%)	Medium (%)	Low (%)	Not a hazard (%)
B. Chemical				
Mycotoxins	2 (4)	15 (30)	28 (56)	5 (10)
Agricultural chemicals	4 (8)	17 (34)	24 (48)	5 (10)
Food additives	2 (4)	20 (40)	24 (48)	4 (8)
Veterinary residues	3 (6)	15 (30)	28 (56)	4 (8)
Mean	2.7 (5.5)	16.7 (33.5)	26 (52)	4.5 (9)
C. Physical				
Pieces of metals, stones,	17 (34)	14 (28)	18 (36)	1 (2)

Twenty (40%) respondents characterised at least one of the listed hazards as of high level. In Table 5.20, the reasons why these hazards were characterised as high level risk are presented. The great majority of respondents (85%) answered that they know that these are high risk hazards.

On the other hand, 8 (16%) of respondents classified at least one of the listed hazards as not a hazard and all of them claimed that they know that these are not hazards (Table 5.21).

Table 5.20: Reasons for characterising the listed hazards as "high level"

Reasons for characterising the listed hazards as high level	Frequency	%
You know that they are high level hazards	17	85
You heard that they are high level hazards	1	5
There was a food poisoning case in another business	2	10

Table 5.21: Reasons for characterising the listed hazards as "not hazards"

Reasons for characterising the listed hazards as not hazards	Frequency	%
You know that they are not hazards	8	100

A more useful interpretation of this risk data of the handling practices of the businesses involved and the kind of businesses need to be considered. For this reason, cross-tabulations between each kind of business and the ranking of hazards are made and presented in Tables 5.22, 5.23 and 5.24.

Table 5.22: Ranking of hazards from the respondents from hotels

Hazard	High level	Medium level	Low level	Not a hazard
Salmonella	6	5	8	0
Staphylococcus	5	4	10	0
E. coli	4	5	10	0
Campylobacter jejuni	3	2	14	0
Clostridium botulinum	3	3	13	0
Spoilage organisms	2	6	11	0
Mycotoxins	0	4	15	0
Agricultural chemicals	2	6	11	0
Food additives	0	7	12	0
Veterinary residues	0	4	15	0
Physical hazards	7	4	8	0
Total	32 (15.3)	50 (23.9)	127 (60.8)	0 (0)

Table 5.23: Ranking of hazards from the respondents from catering businesses

Hazard	High level	Medium level	Low level	Not a hazard
Salmonella	4	5	5	1
Staphylococcus	5	4	5	1
E. coli	4	5	5	1
Campylobacter jejuni	4	4	6	1
Clostridium botulinum	0	5	6	4
Spoilage organisms	4	4	5	2
Mycotoxins	0	4	7	4
Agricultural chemicals	0	4	7	4
Food additives	0	6	6	3
Veterinary residues	2	5	5	3
Physical hazards	4	5	5	1
Total	27 (16.4)	51 (30.9)	62 (37.6)	25 (15.1)

Table 5.24: Ranking of hazards from the respondents from industries

Hazard	High level	Medium level	Low level	Not a hazard
Salmonella	7	2	7	0
Staphylococcus	7	3	6	0
E. coli	6	4	6	0
Campylobacter jejuni	6	3	7	0
Clostridium botulinum	2	7	6	1
Spoilage organisms	7	3	6	0
Mycotoxins	2	7	6	1
Agricultural chemicals	2	7	6	1
Food additives	2	7	6	1
Veterinary residues	1	6	8	1
Physical hazards	6	5	5	0
Total	48 (27.3)	54 (30.7)	69 (39.2)	5 (2.8)

5.1.6 Good hygiene practices and systems applied in the businesses

In this survey, all businesses have cleaning schedules for the premises and the equipment in place. A relatively high percentage of businesses inspect the raw materials and monitor the temperature of the equipment. Monitor of temperature includes the checking of temperature of the equipment using the equipment-fitted thermometer or a portable one. Microbiological testing of food is carried out by only 21 (42%) businesses which is a low percentage.

Table 5.25: Existence of good hygiene practices

Hygiene practices	Frequency	%
Cleaning schedules for the premises and the equipment	50	100
Inspection of raw materials	46	92
Temperature monitoring of equipment	41	82
Microbiological testing of food	21	42

It is also important to assess the number of businesses carrying out microbiological testing within the three categories of businesses (Table 5.26). There are only 3 (15%) hotels carrying out microbiological testing whereas there are 5 (25%) and 13 (65%) catering businesses and industries respectively.

Table 5.26: Number of businesses within each category carrying out microbiological testing

Kind of business	Number of businesses	%
Hotel	3	15
Catering	5	25
Industry	13	65

The practice that is carried out by the most businesses on a daily basis is the cleaning of the premises and the equipment, followed by the inspection of the raw materials and monitoring of the temperature of the equipment and the microbiological.

Table 5.27: Frequency of good hygiene practices

Frequency	Cleaning schedules		Inspection of raw materials		Temperature monitoring		Microbiological testing	
	Number of businesses	%	Number of businesses	%	Number of businesses	%	Number of businesses	%
Daily	36	72	26	56.5	21	51.2	3	15
Weekly	0	0	6	13	4	9.8	2	10
Monthly	2	4	2	4.3	4	9.8	8	40
Every 3 months	3	6	3	6.5	2	4.9	1	5
Every 6 months	9	18	9	19.6	10	24.4	3	15
Every year	0	0	0	0	0	0	4	20

Cleaning schedules, inspection of raw materials and monitoring of temperature guidelines are part of prerequisite programmes of a HACCP system. Thus, their role is very important and their implementation shows a high commitment to the implementation of an effective HACCP system.

Table 5.28: Existence of written guidelines of practices

Practices	Frequency	%
Cleaning schedules guidelines	35	70
Inspection of raw materials guidelines	33	71.7
Temperature monitoring guidelines	32	78
Microbiological testing guidelines	18	85.7

All written guidelines for the practices that are carried out in the businesses were produced by the businesses themselves without any external help.

Any changes in equipment facilities or processes the guidelines should always be reviewed and, if necessary, changed. In Table 5.28, the frequencies of checks and revisions of the written guidelines are presented. The frequency of reviewing guidelines for the majority of businesses was every year.

Table 5.29: Frequency of checking and reviewing of written guidelines

Frequency	Number of businesses	%
Any time it is needed	4	10.8
Every 6 months	9	24.3
Every year	19	51.3
Every 2 years	5	13.5

Almost half (46%) of the businesses apply ISO which is a quality system rather than a food safety system. Another 11 (26%) businesses apply in-house designed systems whereas only 8 (16%) and 3 (6%) apply common sense and experience and GMP respectively. In-house designed hygiene system means the formal guidelines prepared by the business itself, whereas common sense and experience means that the personnel know what to do through their experience and common sense. Another 5 respondents (10%) answered that none of these systems are applied in their food businesses. All these results are found in Table 5.30.

Table 5.30: Food safety / quality systems applied in the businesses

Food safety / quality systems	Number of businesses				%
	Hotels	Catering businesses	Industries	Total	
None	2	1	2	5	10
Common sense and experience	2	6	0	8	16
In-house designed hygiene systems	4	5	2	11	22
GMP	1	2	0	3	6
ISO	10	1	12	23	46

5.1.7 Cross-tabulations

(a) Size of businesses and applied food safety / quality systems

Cross-tabulation of the question concerning whether or not food safety / quality systems are applied in the business and the number of food handlers (size of business) is presented in Table 5.31.

Table 5.31: Cross-tabulation of size of food business and applied food safety / quality systems

Size of food business	Food safety / quality systems				
	None	Common sense and experience	In-house designed hygiene systems	GMP	ISO
A. Small businesses					
1-2 food handlers	0	1	0	0	0
3-4 food handlers	1	2	2	2	0
5-10 food handlers	1	2	3	0	2
Subtotal	2	5	5	2	2
(%)	(12.5)	(31.2)	(31.2)	(12.5	(12.5)
B. Medium businesses					
11-50 food handlers	3	3	5	1	20
(%)	(9.4)	(9.4)	(15.6)	(3.1)	(62.5)
C. Large businesses					
More than 51 food handlers	0	0	1	0	1
(%)	(0)	(0)	(50)	(0)	(50)
Total	5	8	11	3	23

(b) "High level" and "Not a hazard" responses and respondents' level of education

In the following table (Table 5.32), the level of education of respondents that ranked the listed hazards as high level and not hazards are presented. The percentages in brackets are calculated based on the total number of respondents without and with College or University Degree respectively as presented in Table 5.3.

Table 5.32: Cross-tabulation of ranking of hazards and respondents' level of education

Hazards	High level responses		Not a hazard responses	
	Without College or University Degree (%) (n=19)	With College or University Degree (%) (n=31)	Without College or University Degree (%) (n=19)	With College or University Degree (%) (n=31)
A. Microbiological (Listed hazards: 6)				
Total number of respondents	21	45	9	1
Mean number of respondents	3.5	7.5	1.5	0.2
Mean %	18.4	24.2	7.9	0.6
B. Chemical (Listed hazards: 4)				
Total number of respondents	2	9	18	0
Mean number of respondents	0.3	1.5	3	0
Mean %	1.6	0.8	15.8	0
C. Physical (Listed hazards: 1)				
Total number of respondents	3	14	1	0
Mean %	15.8	45.2	5.3	0

The purpose of this cross-tabulation (Table 5.33) is to identify if the size of business is a factor that affects the existence of hygiene practices within the businesses.

Table 5.33: Cross-tabulation of size of business and the existence of hygiene practices

Size of business	Hygiene practices			
	Cleaning schedules	Inspection of raw materials	Temperature monitoring	Microbiological testing
A. Small businesses				
1-2 food handlers (n=1)	1 (100%)	0 (0%)	0 (0%)	0 (0%)
3-4 food handlers (n=7)	7 (100%)	6 (85.7%)	4 (57.1%)	3 (42.8%)
5-10 food handlers (n=14)	14 (100%)	12 (85.7%)	10 (71.4%)	5 (35.7%)
Subtotal (n=22)	22 (100%)	18 (39.1%)	14 (34.1%)	8 (38.1%)
B. Medium businesses				
11-50 food handlers (n=26)	26 (100%)	26 (100%)	25 (96.5%)	11 (42.3%)
C. Large businesses				
More than 51 food handlers (n=2)	2 (100%)	2 (100%)	2 (100%)	2 (100%)
Total	50	46	41	21

5.1.8 The HACCP system in Crete

From the results presented in Table 5.34, 43 respondents (86%) were aware what the HACCP system was and only 7 (14%) did not know about it.

Table 5.34: Frequencies of responses to the question " What is HACCP?"

	Frequency	%
Risk management system applied in food businesses	43	86
Do not know	7	14

The Crete study also tried to identify the sources of information on the HACCP system. Nine (18%) and 22 (44%) answered that they obtained information the

Public Health Inspectors and external consultants respectively. All the results are presented in Table 5.35. Percentages exceed 100 because multiple answers were given by respondents.

Table 5.35: Sources of information on the HACCP system

	Frequency	%
External consultants	22	44
Colleges and Universities	17	34
Other businesses	23	46
Public Health Inspectors	9	18
Internet	5	10
Seminars	2	4

The HACCP system was implemented in 22 food businesses, thus, making 51.2% of food businesses where the respondents knew what the HACCP system was. If however, the percentage is calculated on the total number of surveyed businesses (n=50) then this figure drops down to 44%.

Eight (42.1%) hotels, 1 (6.7%) catering business and 13 (81.2%) enterprises of the food industry implemented the HACCP system.

Table 5.36: Implementation of the HACCP system

	Hotels	Catering	Industry	Total
Number of businesses applying HACCP	8	1	13	22 (44%)
Percentage based on the number of businesses of each category	42.1	6.7	81.2	

The HACCP system was firstly implemented in 1996 by one business (Table 5.37). The number of businesses implemented the system in 1997 and 1998 remained the same, but, after 1998, their number increased.

Table 5.37: Year of implementation of the HACCP system

Year of implementation	1996	1997	1998	1999	2000	2001 (January-November)
Frequency	1	1	1	5	6	8
%	4.5	4.5	4.5	22.7	27.3	36.4

As presented before there were 22 businesses applying the HACCP system in Crete. The great majority of them (76.5%) sought help from external consultants (Table 5.38).

Table 5.38: Sources of help for the development and implementation of HACCP

	Frequency	%
With the aid of the Government	1	4.5
With the aid of external consultants	21	95.5

The most prominent reason for implementing the HACCP system was to increase the safety of food produced in their business (Table 5.39). The second most frequently given reason was to give a commercial advantage to the products produced in their business. Customer pressure is the second least selected reason (25.5%) for the implementation of the HACCP system.

It should be noted that figures in brackets are the percentages and they are calculated based on the total number of businesses of each category that have the HACCP system in place. In addition, the calculated percentages for the total results exceed 100 because respondents gave multiple answers to this question.

Table 5.39: Reasons for implementing the HACCP system

Reasons for implementing the HACCP system	Hotel (%)	Catering (%)	Industry (%)	Total (%)
To increase the safety of food produced in the business	8 (36.4)	1 (4.5)	13 (59.1)	22 (100)
Due to customer pressure	4 (18.2)	1 (4.5)	9 (64.3)	14 (63.6)
Due to legal requirement	3 (13.6)	1 (4.5)	11 (50)	15 (68.2)
To give commercial advantage to the products of the business	3 (13.6)	1 (4.5)	9 (40.1)	13 (59.1)

The HACCP system of eleven businesses (50%) was externally audited (Table 5.40). Government audited 9 (81.8%) businesses and international organizations / agencies were involved in auditing of the remaining businesses (18.2%).

Table 5.40: Auditors of businesses implemented the HACCP system

Auditor	Kind of business			Total	%
	Hotel	Catering	Industry		
Government	1	0	8	9	81.8 *
International Organizations/ Agencies	0	1	1	2	18.2 *
Total number of audited businesses	1	1	9	11	50 **

* The percentage is calculated based on the number of businesses audited externally

** The percentage is calculated based on the total number of businesses implemented the HACCP system

In the respondents' opinion, governmental bodies should conduct more seminars in order to educate all food handlers better on the system. All responses to this question are presented in Table 5.41.

Table 5.41: Ways of improving knowledge on the HACCP system

	Frequency	%
Seminars from governmental officers	17	80.9
Seminars from private experts/consultants	4	19.1
Total	21	100

5.1.9 Cross-tabulations

(a) Size and number of businesses applying the HACCP system

The number of full-time food handlers (as also noted in Chapter 4.1.4) determines the size of business.

Table 5.42: Cross-tabulation of the size of businesses (number of full-time food handlers) and the implementation level of the HACCP system

Category of business	Total number of businesses	Number of businesses implemented the HACCP system	%
A. Small businesses			
1-2 food handlers	1	0	0
3-4 food handlers	7	0	0
5-10 food handlers	8	2	25
Subtotal	16	2	12.5
B. Medium businesses			
11-50 food handlers	32	18	56.2
C. Large businesses			
More than 51 food handlers	2	2	100

(b) Years of operation and number of businesses applying the HACCP system

The duration the businesses been in operation is cross-tabulated with the implementation level of the HACCP system and the results show if there is a correlation between the two.

Table 5.43: Cross-tabulation of the years of operation of the businesses and the implementation level of the HACCP system

Years of operation	Number of businesses implemented the HACCP system				Total number of businesses	%
	Hotel	Catering	Industry	Total		
1-5	1	1	2	4	10	40
6-10	4	0	3	7	22	31.8
11-15	1	0	6	7	12	58.3
> 16	2	0	2	4	6	66.7

(c) Correlation of information of the HACCP system and size of food business

The results of this cross-tabulation determine whether the size of the businesses influence the knowledge of respondents about the HACCP system. The figures in brackets are the percentages of respondents (businesses) who gave the specific answer.

Table 5.44: Cross-tabulation of knowledge about HACCP and size of food businesses

Size of business	Knowledge about the HACCP system	
	Risk management system applied in food businesses	Do not know
A. Small businesses		
1-2 food handlers	0	1
3-4 food handlers	4	3
5-10 food handlers	6	2
Subtotal (%)	10 (62.5)	6 (37.5)
B. Medium businesses		
11-50 food handlers (%)	31 (96.9)	1 (3.1)
C. Large businesses		
More than 51 food handlers (%)	2 (100)	0 (0)
Total (%)	43 (86)	7 (14)

5.1.10 Reasons for non-implementation of the HACCP system in Crete

Where respondents claimed that implementation of the HACCP system will cost too much money, an estimate of the amount was asked in the study. In cases where there was a company's decision to implement the HACCP system, the time schedule of implementation was sought.

The most frequent reason for non-implementation of the HACCP system was that it was at the development stage. All the results of this question are presented in Table 5.45.

Table 5.45: Reasons for not having implemented the HACCP system

	Frequency	%
It is not required	2	9.5
It costs too much money	8	38.1
It is at the development stage	11	52.4

The study sought to find out the level of costs that respondents thought they would invest for the HACCP system development and implementation. The percentage was calculated based on the total number of respondents who answered that the HACCP system costs too much money (n=8).

All the results are given in Euros in Table 5.46.

Table 5.46: Estimated cost of HACCP implementation

Euros	Frequency			Total	%
	Hotels	Catering businesses	Industries		
Up to 17,000	3	1	0	4	50
17,001 – 34,000	2	0	1	3	37.5
34,001 – 51,000	0	0	0	0	0
51,001 – 68,000	0	0	0	0	0
68,001 – 85,000	0	0	0	0	0
More than 85,001	1	0	0	1	12.5

5.1.11 Development and implementation of the HACCP system

The future plans of businesses for the development and implementation of the HACCP system are presented in Table 5.47. This question was addressed to the respondents who gave other than "don't know" responses excluding respondents from businesses applying the HACCP system (n=21).

Table 5.47: Year of development and implementation of the HACCP system

	Frequency	%
Next year	10	47.6
In two years	8	38.1
After three years	3	14.3

5.2 Discussion of the results of the Crete study

As noted in Chapter 5.1, the survey covered a total number of 50 food businesses, which represents the 2.7% of the total number of food businesses in the Heraklion County. In Cyprus, the surveyed businesses represented the 6.9% of the total number of businesses.

5.2.1 General information

5.2.1.1 Age, position in the business and level of education of respondents

Most respondents were between the ages of 30 and 49. This distribution of respondents' ages was similar to the results of Cyprus survey. The reasons for that distribution are the same as described in Section 4.2.1.

Based on the results of Table 5.2, only 28% of the respondents were the owners and the remaining 72% were senior employees. From the latter category, production line supervisors were in the first place, comprising 34% of respondents followed by the chefs (18%), managers comprised 8% and quality control supervisors accounted for 6%. These results are very different compared to the results of the Cyprus survey, as the owners did not represent the most frequent respondent in the business. This means that there was a different distribution of responsibilities in the businesses, particularly for food safety / hygiene matters.

Moreover, the great majority of respondents from hotels were chefs and production line supervisors not. In industry, only half of respondents were production line supervisors.

5.2.1.2 Level of education of respondents and kind of food business

The education system in Greece is based on the same principles as the system in Cyprus and consists of twelve years from grade one to grade 12. Primary education means from grade 1 to grade 6, the high school mean up to 9 and the lyceum means grade 12. Diploma is obtained after 2 or 3 years of college course.

There are 32 Advance Educational Institutions (AEI) and Technical Educational Institutions (TEI) in Greece. In 2001, 8200 applicants from a total number of about 12000 entered into the Advance Educational Institutions and Technical Educational Institutions of Greece (Papamatthaiou, 2002). The total number of students in tertiary education (only in Greek Institutions) increased from 2000 in 1960 to 50000 in 2002 (Papamatthaiou, 2002).

The Crete study covered the same three categories of food businesses as the Cyprus survey. Industry and hotels represented 11.2% and 11.4% respectively whereas in the case of catering businesses 5% of the total number of each kind of business.

5.2.2 Cross-tabulations

(a) Age of respondents, position in the business and kind of food businesses

The owners between the ages of 20 and 49 were from catering businesses, whereas those of ages of 50 and 59 were typically from industry. The same trend was observed in the Cyprus survey too as the respondents who were owners came from catering businesses and industry and not from hotels.

All the chefs came from hotels because this position is only found in this sector and none of them was younger than 29 year old.

A production line supervisor is the person responsible for the production line in a food business. Generally, in cases where there is more than one line, there is more than one designated for this position. Almost all production line supervisors were respondents from hotels and industries and only one of them worked in a catering business. The great majority were between the ages of 30 and 49.

All food technologists were respondents from industry. Quality control supervisors were from hotels (between the ages of 20-29).

(b) Age of respondents and their level of education

Table 5.8 shows that younger respondents have a higher general education. This was also found in the Cyprus survey. This is a reflection of the general situation in Greece; younger generation tend to be better educated. Eurostat, the statistical service of European Community, in a report published in October 2002 and referred for the year 2002, stated that between the ages of 18-21, 60% of population enrol in tertiary education (European Commission Statistical Service, 2002). This percentage drops down to 8.5% for the age group 22-24 and to 3% for the age group 25-28 in Greece (European Commission Statistical Service, 2002). As the duration of studies in Greece leading to a Bachelor's Degree is 4 years (Kanellopoulos, 1996), it is obvious that a high percentage of students finishing the Lyceum (secondary education) enrol in a University to continue their studies. The education is delivered by public and private schools, colleges and universities which are based throughout the whole country. Many young people also go abroad for postgraduate studies (Masters' degree or PhD).

(c) Position in the business and level of education of respondents

Owners were found to be the least educated of the respondents, as 92.9% have not acquired a Diploma or a University Degree. This figure was higher than the figure derived from the results of the Cyprus survey which was 67.4%. The possible reason for that is the fact that the area under question is a tourist area and food businesses were highly profitable, thus many people who did not have any other occupation, decided to establish and run such a business.

The level of general education of respondents who were not owner was much higher as more have acquired a Diploma or University Degree something which was also observed in the Cyprus survey. The competition for such positions ensures that education, knowledge, and experience in the field are of high levels.

(d) Level of education of respondents and kind of food business

Hotels and industries employed less people with only a Lyceum Leaving Certificate in contrast with catering businesses where most respondents had acquired only such a Certificate. Furthermore, hotels employed more respondents with a Diploma or a Bachelors degree than industries and catering businesses. The same attitude was also observed in the Cyprus survey.

The reason for both results is that hotels, large industries and catering businesses have more structured management systems thus they have to employ such well educated in order to have a qualified person in each position.

5.2.3 Nature of business and mode of operation

Meat, poultry, fish, bakery, confectionery, rice, milk and their products were selected by more respondents because these products are handled in almost all hotels and in the majority of catering businesses. Generally due to the fact that the menu in all hotels is too wide, it is obvious that a variety of products are handled. On the other hand, respondents from the food industry selected only the kind of products that are associated with the type of industry they work in, so their contribution to the total number of products was not so significant.

In both surveys, the first three most frequently handled products were the same. These products were the meat, poultry and fish. The reason for that is that in both countries, dishes prepared and served to customers are similar and are mainly based on meat (pork, lamp and beef) and poultry recipes. Although based in the region, Cypriot and Cretans consume meat and meat products almost daily and not (as prescribed by Mediterranean diet) 3-4 times per month and poultry 1-2 times per week.

However, in the Crete study, more respondents in comparison with the Cyprus survey selected these products (i.e. meat, poultry and fish and their products) because of the larger number of hotels surveyed in Crete in which these products were almost always handled.

As shown in Table 5.12, the roasting, frying, boiling, baking and pasteurisation processes are employed more often in the Cyprus than in the Crete study.

As mentioned in Chapter 4.1.4, the number of full time food handlers is a very important criterion for the categorisation of businesses. Crete is a small island and its economy is propelled by Agriculture and Tourism, with the latter sector playing a more significant role in terms of its contribution to the Gross Regional Product (GRP) and employment (Chamber of Commerce and Industry of Heraklion, 2002). A high percentage of catering businesses in Crete are small businesses and employ a small number of staff because of the narrow turnover and amount of work (Kokkinakis Manolis and Kotsaki Filia, 2001, personal communication). Twenty-two (44%) of the surveyed businesses were small businesses (businesses with less than 10 food handlers) and about two-thirds of them were catering businesses. However, this percentage was much lower than that the one revealed from the Cyprus survey. One reason for that is the fact that the percentage of surveyed catering businesses was lower than that of the Cyprus survey (45% in the Cyprus survey and 30% in the Crete study) so their contribution to the total number of small businesses is not so evident.

In Table 5.13, 44% of the surveyed businesses were small and another 52% were medium businesses which gives a total figure of 96%. This figure was higher in the Cyprus survey and reached the 97.3%. However, the results showed that the medium businesses in Crete were present much more than in Cyprus survey.

Other characteristics of small businesses in Crete are similar to the small businesses in Cyprus, i.e. they serve local customers, have a very limited share of the available market, are owned by one person or by a small group of people, are managed by their owners who deal with all management issues, usually with little other help, and they are independent businesses.

In the Cyprus survey, small hotels represented 44.9% of surveyed hotels and the medium hotels 51%. In the Crete study, small hotels represented only 21% of the surveyed hotels, whereas the medium sized ones accounted for 73.7% of the total. The same trend was observed for Crete industries where small ones were much less in number than medium ones. On the other hand, in Cyprus small companies of the food industry were greater number than medium sized ones.

Table 5.14, indicates that food industry employ more food handlers than hotels and catering businesses, with the latter employing only 5.4 food handlers per business. These results support the features of the small businesses and particularly of the catering businesses given in this Chapter.

Table 5.15 shows that hotels and industries employed more food handlers per business whereas in the case of catering business less food handlers per business.
A consequence of these results was what was identified before i.e. medium hotels and industries were much more (as a percentage) in the Crete study than in the Cyprus survey. All catering businesses in the Crete study were small businesses thus the mean number of food handlers was smaller than in Cyprus survey.

The possession of a valid Health Certificate by all food handlers is mandatory. The procedure of its issue is described in Chapter 5.1.3. The percentage of employees with a valid Health Certificate (as shown in Table 5.16) can be assessed as relatively high taking into consideration that many food handlers were in the process of renewing their Health Certificate.

The great majority of temporary food handlers were employed by catering businesses and industry and not by hotels. The food industry employed more temporary food handlers than catering businesses and this was due to the larger size of these enterprises. However, temporary food handlers in both surveys were employed for the same reasons i.e. seasonal nature of work and fluctuating turnover of workforce.

The problems of employing temporary food handlers and the remedial measures to be implemented are found in Chapter 4.2.4.

The number of temporary food handlers with a valid Health Certificate was smaller than the Cyprus survey as only 60.7% of them possessed such a Certificate. In this view, efforts should be addressed so as, as many temporary food handlers as possible possess a valid Health Certificate and follow a basic food hygiene training.

5.2.4 Inspections of the businesses by Public Health Inspectors

Public Health Inspectors carry out sanitary inspections to all food businesses in order to identify poor/good hygiene practices, substandard environmental conditions or structural deficiencies so as to suggest the necessary remedial measures.

The weaknesses of the traditional sanitary inspection were identified by De Sitter and Van de Haar (1998) and presented in Chapter 4.2.5 and apply to the situation in Greece and therefore in Crete (Kokkinakis Manolis and Kotsaki Filia, 2001, personal communication).

The results in Table 4.19 indicate that all food businesses were inspected in intervals between 9 months to 3 years. The interval between the inspections is based on the risk category of each business.

The sanitary inspections carried out in Crete by Public Health Inspectors are based on the same principles are those carried out in Cyprus. The frequency of inspection is higher in the Cyprus survey.

As presented in Chapter 5.1.4, the mean interval of the sanitary inspections carried out in the surveyed businesses were 7 months. All businesses are inspected every two years and this is a very large interval and therefore the progress against food hygiene and safety cannot be checked in those businesses.

However, the basis of the sanitary inspections is necessary to change so as to accommodate all changes that have been introduced in the whole food chain, from the production to the consumption stage. Many food safety and quality systems (risk based systems) applied in food businesses are based on a proactive and preventative approach, moving away from the notion of end product testing. This new approach will require an enormous time commitment from enforcement officers, as for many small businesses, their sole source of information about food safety issues and legislation comes from food safety enforcers in the USA (Rennie, 1994).

5.2.5 Hazard awareness

The results of Table 5.19 suggest that businesses in Crete did not recognise microbiological hazards that were significant to them or they did not characterise them as “high risk”. Among the listed microbiological hazards, Salmonella and Staphylococcus were categorised as “high risk” by the highest percentage (34%) of respondents. This reflects the fact that a lot of publicity was given by mass media to Salmonella and Staphylococcus food poisoning in Greece and, therefore, they are well known (Ehiri *et al*, 1997a). The Cyprus survey showed similar results but only for Salmonella.

Salmonella, Staphylococcus, E. coli and C. jejuni were also classified by the smallest number of respondents (2%) as "not a hazard" compared to other hazards and to the results of the Cyprus survey for the same hazards.

For the remaining microbiological hazards, the "high risk" responses decreased and the "not a hazard" responses increased. In comparison with the results of the Cyprus survey, it is clear that fewer respondents from Crete considered them as "not hazards". These microbiological hazards were considered as hazards but not to the level they actually represent for the public health. It can also be concluded that there is insufficient knowledge and not lack of knowledge.

As regards the chemical hazards, a low percentage (9%) of respondents did not consider them as hazards, which is a lower percentage than the results (50.9%) from the Cyprus survey. The effect of chemical contamination on the consumer as referred in Chapter 2.4.2, can be long-term (chronic) or it can be short-term (acute). In both cases the severity of the effects could be very high and, in any case, chemical hazards represent high risk to public health.

Physical hazards were characterised by more respondents as "high level" risk in comparison with microbiological and chemical ones. The reason is that they are the most commonly reported to be found in foods because they are very easily identified as the ill health effects occur immediately or soon after eating. On the other hand, the least respondents considered them as not hazards compared to microbiological and chemical hazards and compared to the results of the Cyprus survey. It seems that the Cretan respondents had better knowledge of these hazards than Cypriot respondents.

Generally, the ways of acquisition of information on food hygiene / safety issues and, therefore, on the hazards involved in any kind of food processing is the same as described in Chapter 4.2.6. They are education, training and / or experience and the publicity and public health warnings when a hazard has been linked with an outbreak or the consequences of this outbreak. The latter and the impact of mass media on food hygiene education was the subject of a survey carried out by Griffith *et al* in 1996. That survey revealed, among others, that mass media is very successful in communicating health information to people as it reaches a large audience. However, the quality of advice given by such means can vary significantly.

In Table 5.20, respondents identified hazards which they deemed as "high level" and they were aware of the severity and significance for public health of these hazards and the business they work for.

On the other hand, the reasons for the "not a hazard" responses varied. A known hazard can be characterised as "not a hazard" only in the case that the products produced and handled in a specific kind of business do not allow the survival and growth of the microbiological or chemical hazard under question. Thus, the correct answer was "Not favourable conditions for survival of such hazards". In the case of the Crete study, no respondent considered the listed hazards as high level because he / she was warned by Health Inspector that they are such hazards.

The reason "there was a food poisoning case in another business was selected by 10% of respondents so a publicity is given by mass media or by word of mouth in such cases.

Respondents from industry were more aware of hazards as they represented the highest percentage of respondents answering "High level". In addition, more respondents from catering businesses than from hotels considered the listed hazards as high level. However, no respondent from any of the hotels answered "Not a hazard" in this question instead they deemed them as low, medium or high level hazards.

The general picture from the results of the Crete study is that the knowledge of respondents from food industry on these hazards was better than that of the other two surveyed categories of food businesses.

As noted in Chapter 4.1.2, typically catering businesses are characterised as high-risk businesses because of the products they handle. In addition, Sheppard *et al* (1990) based on statistical evidence, indicated that outbreaks of food poisoning are most commonly associated with this sector. Having this in mind it was expected that respondents from catering businesses in the Crete study would have regarded themselves as high-risk businesses as in the Cyprus survey. However, this was not the case as only 16.4% of respondents (the same percentage was derived from the results of the Cyrus survey) assessed their business' risk to food safety as of high level. These results are similar to the survey carried out by Mortlock *et al* in 1999 in UK where only 16% of respondents from retail and catering sector identified themselves as high-risk in terms of food safety. The same distribution, between the two surveys, was observed for the remaining medium and low-level responses.

5.2.6 Good hygiene practices and systems applied in the businesses

The same principles for the listed practices apply for the Crete study as those described in Chapter 4.1.7 for the Cyprus survey.

From the results, all businesses had in place cleaning schedules for the premises and the equipment. A very high percentage of businesses (92%) followed the inspection of raw materials regularly. On the other hand the temperature monitoring of equipment was applied by 82% of businesses. Taking into account that temperature is a very important weapon against the survival and multiplication of microorganisms (Chapter 2.4.1), this is a low percentage.

The percentage of businesses which carried out microbiological testing of food was low. However, as this practice should be included in every HACCP system, then based on the percentage of the businesses implemented the HACCP system (44%) the percentage was expected to be higher than 42%. Furthermore from the results presented in Table 5.26, it is clear that more food industry companies carried out microbiological testing than catering businesses and hotels.

What should be noted is that in the case of the food industry, microbiological testing can be very useful as their products are consumed in a very short time, whereas food prepared by hotels and catering businesses food is consumed shortly after its production. In any case, microbiological testing is used mainly for monitoring purposes in the framework of the HACCP system or Good / Hygiene Manufacturing Practices applied in the businesses.

Comparing these results with the results of the Cyprus survey and a UK survey, this practice is more common among catering businesses in Crete than in Cyprus and UK. In the UK and Cyprus surveys only 7.9% and 18.5% of catering businesses respectively carried out this practice (Mortlock *et al*, 1999). On the other hand, only 53.4% of industries in Cyprus and 62% of Crete industries carried out this practice compared to 71% in UK (Mortlock *et al*, 1999).

Another survey carried out in Glasgow, showed that microbiological sampling was not undertaken by any of the surveyed catering businesses (Ehiri *et al*, 1997a). Instead, 78% of them retained meal samples for microbiological testing in case of suspected food poisoning (Ehiri *et al*, 1997a).

The frequencies of the practices are very important in order to accomplish their purpose. However, as presented in Table 5.27, the first three practices namely cleaning of the establishment and the equipment, inspection of raw materials and temperature monitoring of the equipment were not carried out every day as should be done.

The principles for the written guidelines are the same as in the case of the Cyprus survey. Their existence is of paramount important, as all employees can then be made aware of the proper procedures to be followed. Furthermore, another kind of paper work – the documentation in the HACCP system – is very important and as stated by the Codex Alimentarius Commission (Codex Alimentarius, 1997). A survey carried out within the Derby City Council boundary in UK concluded that the standards of hygiene were better during preparation and cooking in those premises with documented hazard analysis systems compared to those without (Walker & Jones, 2002).

From the results of Table 5.28, a high percentage of businesses which employed the listed practices (cleaning of the premises and the equipment, inspection of raw materials, temperature monitoring and microbiological testing) had written guidelines in place. However, there were more businesses having written guidelines for microbiological testing of food than the other practices. For all four practices, more surveyed businesses from Crete had in place written guidelines than those from Cyprus.

The great majority of businesses (75.6%) in this survey checked and reviewed the written guidelines every 6 to 12 months, an interval which can be consider as satisfactory taking into account that there are not any changes which need immediate alterations on the guidelines. Almost the same distribution was observed in the Cyprus survey in which 74.3% of businesses having written guidelines checked and reviewed every 6 to 12 months.

More than two thirds of businesses in the survey ensured the safety of food using their "common sense" and experience and in-house designed systems. The limitations of these "systems" are described in Chapter 4.2.7.

In this study more businesses compared to the Cyprus survey had no food safety / quality system in operation.

Almost half of the surveyed businesses in this study run/based on ISO (International Standard Organisation) standards but this has to do more about the quality of the food products and not for their safety. However it should be noted that ISOs are very important and useful as they can be characterising as a starting point for establishing an effective food safety system. (See also Chapter 2.7.1)

5.2.7 Cross tabulations

(a) Size of food business and applied food safety / quality systems

The limitations for small businesses in relation to the implementation of a food safety / quality system presented in Chapter 4.2.8 also apply to the food businesses in Crete.

Small businesses in Crete followed more often the "common sense and experience" and "in-house designed hygiene" systems than the ones in the Cyprus survey. Furthermore Good Manufacturing Practices (GMPs) and quality standards (ISO) were applied less frequently in both surveys.

As regards the medium businesses, quality standards were better implemented. 62.5% of them applied ISO, in contrast to the Cyprus survey where only 36.1% of them implemented it. In-house designed hygiene systems and common sense and experience were relied on by more businesses in the Cyprus than in the Crete study.

(b) Cross-tabulation of "High level" and "Not a hazard responses" and respondents' level of education

The Crete study revealed that the level of general education of the respondent had a direct effect on the responses to the food handling questions, as there is a positive correlation between the level of education and the correct identification of microbiological and physical hazards. However, in the case of chemical hazards, the level of education of the respondents did not have a significant effect on their identification of level of hazards. The Cyprus survey showed similar level of understanding of these hazards.

As regards the "not a hazard" responses, the correlation was the same as the "high level" responses on the microbiological hazards. This means that less College and University degree holders than the non-holders characterised the listed hazards as not hazardous to public health. Nc respondent with College or University Degree answered that chemical and physical hazards were not hazards. This distribution was observed in the Cyprus survey as well, thus the general comment made at the beginning of this section is confirmed.

(c) Cross-tabulation of size of business and the existence of hygiene practices

There is a positive correlation between the size of business and the existence of the listed hygiene practices, particularly for small and medium businesses. Moreover, the tendency was observed in the Cyprus survey.

Businesses employing more food handlers were much more likely (steady increase of the percentage) to have these practices in place. This also showed that larger businesses were fully aware of the importance of these practices.

5.2.8 The HACCP system in Crete

86% of respondents from the Crete study were aware of the HACCP system. This figure is high compared with the results of the Cyprus survey (see Chapter 4.2.9) and to similar surveys carried out in UK and Ireland where only 41% and 48% respectively had heard about the HACCP system (Ehiri *et al*, 1997a; Food Safety Authority of Ireland, 2001).

The sources from which respondents took their information about the HACCP system were dissimilar from those in the Cyprus survey. Other businesses were the best source of information about the HACCP system. This means that the co-operation between the food businesses in Crete and particularly, between hotels is well developed. In contrast, a survey carried out in Ireland by the Food Safety Authority of Ireland in 2000 showed that only 13% of respondents claimed that they received knowledge about the HACCP systems from their colleagues (Food Safety Authority of Ireland, 2001). It is not possible to assess whether information given was sufficient and helped in understanding properly the HACCP system.

External consultants were the second most frequently selected source of information on the HACCP system. These results are lower than the Cyprus survey but higher than that of the survey, carried out in UK by Panisello *et al* (1999).

The third source of information was advice received from Colleges and Universities. In the Crete study, more than two-thirds received knowledge about the HACCP system from this source. The results of a study which was carried out in UK showed that 37% of respondents received their information from Colleges and Universities (Panisello *et al*, 1999). Another study carried out in Ireland showed that only 15% of respondents received information on the HACCP system from this source (Food Safety Authority of Ireland, 2001).

The Laboratory of Clinical Bacteriology, Parasitology, Zoonoses and Geographical Medicine of the University of Crete organises and conducts seminars and workshops for food handlers in food hygiene / safety and the HACCP system (Kokkinakis Manolis 2003, personal communication).

Public Health Inspectors occupied the fourth place in contrast with the results of the Cyprus survey in which they occupied the first place. The low percentage of respondents gave Public Health Inspectors as a source of information is consistent with the results in Table 5.18 where inspections of food businesses were not carried out regularly.

As regards the Internet, the general problem is that it is not accessible to all people working in food businesses. This is probably the reason for the low percentage of respondents who used the Internet to access information on the HACCP system.

However only 4% of respondents obtained knowledge regarding the system by attending to seminars. This figure is well below the figures from other surveys including the Cyprus survey and the Food Safety Authority of Ireland survey (2001).

The implementation of the HACCP system is the target of food regulatory authority in every country authorities and food businesses share a common goal, to ensure the safety of foods (Tompkin, 2001).

The Crete survey showed that the implementation level of the HACCP system was 44% which is much higher than the results of the Cyprus survey (the implementation level was 17%). Furthermore, the percentages of the HACCP system implementation in UK in three surveys carried out from 1995 to 1998 were 23, 72.6 and 38.2 respectively (Ehiri *et al*, 1997a; Panisello *et al*, 1999 and Mortlock *et al*, 1999). Another survey carried out in Ireland in 2000 showed that 74% of businesses had a food safety management programme in place. However, only 71% of them have written procedures / system (Food Safety Authority of Ireland, 2001). Furthermore, a survey among the 322 Brazilian fishery plants revealed that only 22% of them had an approved HACCP plan in place and 3.4% had a non-approved HACCP plan in place (Donovan *et al*, 2001).

As regards the implementation of the HACCP system among the three categories of businesses, it was clear that more enterprises of food industry and hotels operated it than catering businesses. These results are similar to the results of the Cyprus survey. The results of the three surveys carried out in UK showed a variation of implementation. In particular, Mortlock *et al* (1999) found that 15.6% of catering businesses and 92% of food industry applied the HACCP system. Panisello *et al* (1999) revealed that 37% of catering businesses and hotels and 50% of enterprises of the food industry implemented the system. Finally, the implementation rates for catering businesses and the food industry in the survey carried out by Ehiri *et al* (1997a) were 4% and 56% respectively.

The first business in Crete implemented the HACCP system in 1996 was an ice cream factory. The number of businesses implemented the system was steadily increased in the following years. Thus a number of businesses implemented the HACCP system before 4th October 2000 when it became a legal requirement in the Greek legislation framework (Official Gazette of the Hellenic Republic, 2000). This signifies far-sightedness of the businesses in question.

The survey carried out in the UK dairy sector in 1998 revealed that only 7% of the total number of businesses had the system in place before it became legally mandatory (Henson & Holt, 1998). However, afterwards the implementation rate of the HACCP system steadily increased.

The great majority of businesses (95.5%) in Crete indicated that the HACCP system was implemented with the aid of external consultants. However, they are not liable by any Law to be registered by a governmental body or to have a licence to practice this occupation (Kokkinakis Manolis and Kotsaki Filia, 2001, personal communication).

The first two major reasons for implementing the HACCP system (increase in food safety and legal requirement) were similar to the Cyprus survey. However, the HACCP system implementation was not legally required in Cyprus during the conduction of the survey. A survey carried out in Australia in 2000 revealed however that only 5.9% of the businesses implemented the HACCP system because of State regulatory requirement (Department of Agriculture, Fisheries and Forestry of Australia, 2001).

Customers' pressure is the second most important factor – 37.5% – of businesses applied the HACCP system in UK as the survey carried out by Panisello *et al* revealed (1999). In the Crete study, the percentage of respondents deemed as a reason for implementing the HACCP system was much higher. Commercial pressure was also deemed an important factor in the adoption of the HACCP system in the dairy sector in the UK (Henson & Holt, 2000).

Half of surveyed businesses implemented HACCP were externally audited (Table 4.40). These audits were conducted either by Government Department or by International Organisations. No private consultant / auditor audited any food business.

Officers from the EFET (Hellenic Food Authority – a government department) have the right to audit the HACCP system of any business. International Agencies (bodies that audit the HACCP system of food businesses) audited 2 businesses.

A survey carried out in the UK dairy sector in 1998 revealed that 93% of the businesses that fully implemented the HACCP system were externally audited (Henson & Holt, 2000).

Another survey carried out in Australia in 2000, revealed that 14.6% of respondents were of the opinion that they gained a great value from the audit process and a further 42.1% some value (Department of Agriculture, Fisheries and Forestry-Australia, 2001). However, they highlighted a number of audit-related issues of food safety and quality systems:

(a) Substantial and varying audit costs and duration,
(b) Differences in auditor competence and effectiveness and
(c) Confusion surrounding current auditing processes (this meant confusion of businesses as to the authorized bodies to perform these audits) (Department of Agriculture, Fisheries and Forestry - Australia, 2001).

The advantages of assessing the HACCP system by the regulatory authorities are presented in Chapter 4.2.9.

Private consultants were the second most important source of information that helped Cretan businesses to learn more about the system. Respondents were of the opinion that these consultants should conduct more seminars in order to improve the knowledge of businesses about the HACCP system.

5.2.9 Cross-tabulations

(a) Total number of full-time food handlers and number of businesses implemented the HACCP system

As it was expected, the level of implementation of the HACCP system was positively correlated with the size of food businesses. These findings were similar to the Cyprus survey and to the results of a survey carried out in UK in 1999 (Mortlock *et al*) the results of which showed that small food manufacturing companies were significantly less likely than their larger competitors to implement the HACCP system.

Both result in insufficient understanding of the application of the HACCP principles. Small businesses tend to think in terms of productivity rather than safety and regard the System as complicated (Panisello *et al*, 2001). The same reasons apply to situation in Greece and Crete in part this is because the economic growth in both is not very high.

Larger food businesses are aware of the value of their reputation and. Therefore try to invest resources for the implementation of the HACCP system whereas smaller businesses have other agendas. Small businesses prefer to invest in the area of production to improve quantity rather than the safety of foodstuffs (Forsythe and Hayes, 1998).

(b) Years of operation of businesses and number of businesses implemented the HACCP system

The duration of the business' operation did not influence the rate of the HACCP system implementation within the specified categories. These results are similar to the results of the Cyprus survey.

The newly established businesses and businesses which have been founded for more than 16 years were more likely to implement the HACCP system. New businesses are more likely to use more sophisticated methods. Furthermore, a food safety system like HACCP, is easier to develop at the same time as the business is being established.

On the other hand, the management of well-established businesses may better understand the need to adapt to new trends in food safety control in order to maintain their reputation. Similarly, the experience progressively gained by owners may help in the better understanding of the necessary changes to be made.

(c) Knowledge of respondents about the HACCP system and size of food businesses

There is a positive correlation between the size of the businesses and the better understanding of the HACCP system. Thus, the respondents from businesses employing more food handlers are more aware of the system. On the other hand, there is a negative correlation between the size of the businesses and the ignorance of the respondents about the HACCP system. The above result shows that the size of the business plays a vital role in the knowledge of food hygiene and safety matters and specifically of the HACCP system. The reasons for that are given in Chapter 4.2.8.

5.2.10 Reasons for non-implementation of the HACCP system in Crete

The reason "it is not required" was selected by 9.5% of respondents. This percentage was not very high and was more or less as the percentage of the Cyprus survey. These respondents were totally unaware either of the HACCP system itself or its benefits, or the legal obligation for the development and implementation of it. Another reason for this attitude is the weak market-based incentives which are a negative factor for the adoption of the HACCP system (Henson & Holt, 2001).

Panisello *et al* (1999) revealed that 54.5% of respondents from the businesses, in the UK survey that did not have the System in place gave the reason "it is not required", which is a higher percentage compared to the results of the survey carried out in Cyprus and Crete.

Economic constraints are a practical barrier to implementing the HACCP system. These constraints may mean that the provision of the assistance by government or industry / trade association or the capacity of the business itself to implement the HACCP system is considerably reduced (WHO, 1999; Codex Alimentarius, 1999). Furthermore these respondents did not know the long-term savings that could be achieved if the HACCP system was implemented.

The costs of the development and implementation of the HACCP system was an important factor for respondents not to develop it.

Half of respondents (three quarters were from hotels) believed that the system would cost up to 17000 Euros. Another one third of respondents answered that the development of the HACCP system would cost between 17001 to 34000 Euros and the remaining 12.5% more than 85001 Euros. It seems that food businesses in Crete were more aware of the costs involved for the development and implementation of the HACCP system than those in Cyprus.

In a survey carried out in Australia in 2000, 47.8% of respondents estimated the development and implementation of the HACCP system cost to be higher than the real costs involved (Department of Agriculture, Fisheries and Forestry of Australia, 2001).

As presented in Table 5.47, 47.6% of Cretan respondents claimed that they would develop and implement the HACCP system in the following year, that is 2002 (the conduct of the survey was the end of 2001). Therefore it might be assumed that by they end of 2002, all these businesses will have developed and implemented the HACCP system.

A high percentage of respondents answered that they would develop the system in two years time (2003).

6 FINAL DISCUSSION

6.1 Barriers to the implementation of the HACCP system

From the 1970's the HACCP system has been progressively introduced and implemented by food businesses worldwide (Panisello & Quantick, 2001), but the level of implementation vary significantly between countries (Panisello *et al*, 1999; Mortlock *et al*, 1999; Ehiri *et al*, 1997a; Food Safety Authority of Ireland, 2001). Until this survey the application level of HACCP by the various sectors of the food industry in Cyprus was not known. This work has identified particularly low levels of implementation among the medium and small businesses.

For the purposes of this research the barriers faced by food businesses for the implementation of the HACCP system can be divided into external and internal ones. The external barriers are these barriers that cannot be controlled by the food businesses themselves. Internal barriers arise from within the food businesses.

6.1.1 External barriers

6.1.1.1 Government commitment and support

Clear manifestation of the Cyprus Government commitment is, probably, the single most important external factor in the development and implementation of a successful HACCP system.

The government support is particularly needed for small businesses. However, there is a problem of the dual role of the government officers who have to be the educator and the enforcer of the legislation simultaneously. This dilemma makes effective enforcement difficult and has, probably, contributed to inconsistency of the HACCP system application (Food Standards Agency, 2002)

The responsibilities of the Cyprus Government have increased in the context of the accession to the EU. Special attention should be given to the small food businesses as these face the financial difficulties in developing a food safety management system.

The enforcement authorities can facilitate the development and implementation of the HACCP system by providing food businesses with guidelines. Article 5 of the Council Directive 93/43/EEC on the Hygiene of Foodstuffs, states that the competent authorities should encourage the development of guides to Good Hygiene Practice which may be used voluntarily by food businesses (as well as a guide to develop and implement the HACCP system). In addition, the Cyprus food legislation and, particularly, the Hygiene and the Official Control of Foodstuffs Regulations of 2002, state that guides to Good Hygiene Practices can be developed by food businesses associations and other bodies, such as, the Cyprus Chamber of Commerce and Industry and the Consumers Association. These guides should be based on the provisions of the International Code of Practice of the Codex Alimentarius and should be approved by the Minister of Health.

6.1.1.2 Business and customer demand

Food safety is an important part of business-to-business dealings throughout the food chain. Businesses expect their suppliers to produce, transport, and deliver safe foodstuffs. To achieve this, there should be a food safety management system in place. As the HACCP system is legally mandatory in Cyprus, then food businesses should exercise their legal right and require their suppliers to have such a system in place. Customers need to use this legislation to ensure that food they purchase is safe.

In the last decade consumers have started to seek foodstuffs with less processed, fresher and more natural characteristics (Jouve, 2000). They are also concerned more about foodborne illnesses. Consumers can influence change in regulatory and industry use of technology; product labelling and consumer education (Bruhn, 1997) and, therefore, they can be a vital driving force for food businesses to implement the

HACCP system. In Cyprus, the first and only consumer association (Cyprus Consumers Association) was established in 1973. However, more should be done and more pressure should be put on the industry.

6.1.2 Internal barriers

6.1.2.1 Management commitment

As noted in Chapter 2.5.2, involvement of the senior management in the preparation, development and application of the HACCP system is of fundamental importance. Thus, a real commitment for the HACCP system will only be achieved if the management team understands fully what the system is all about and, mainly, about the following parameters:

(a) The reason for using it,
(b) The expected benefits,
(c) What resources will be required (e.g. time, costs, manpower) and
(d) Any likely impact on other aspects of the business (e.g. improvements in Good Manufacturing Practices).

In many instances in the Eastern Mediterranean Region, the HACCP system is viewed by the senior management as a bureaucratic burden imposed from outside, rather than as an essential tool in the management of product safety. Managers who have negative attitude towards the HACCP system have the opinion that their business had operated for many years without serious problems or complaints. It is, unfortunately, the case that senior management can be influenced more by economics than the safety factors of the products.

6.1.2.2 Human resources / expertise and training

Human resources are vital assets (WHO, 1999) and must be used effectively by all the business involved with foodstuffs (Mortimore & Wallace, 1994) for the proper development or implementation of the HACCP system. However, small businesses tend to employ only the staff they need to carry out production tasks. The priority is productivity rather than safety (Panisello *et al*, 2001). Small and medium businesses can be described as having a busy day-to-day existence without designated staff to get involved in long-term planning of non-essential activities.

Furthermore, the establishment of a HACCP team is often a problem for food businesses. The selection of team members can be problematic because the members should have the relevant knowledge (e.g. microbiologist, production line manager, engineer). In large businesses, some managers want to become team members on the grounds that they know everything about equipment; procedures and practices or that because other employees are too busy / have other commitments.

The major difficulty for the Cyprus small businesses is finding experienced and / or technically trained people with the relevant expertise to appreciate all the potential risks. On the other hand, employees of the small businesses tend to be really close to the process and have in-depth knowledge about the processes carried out. (Taylor, 2001; Route, 2000; Mortimore, 2001).

Another factor that is critical to the successful implementation of the HACCP system is effective training. Training must cover all the personnel of a food business, both the senior management and the rank and file employees. It has three main roles (Wallace, 2000):

(a) To develop awareness and motivation in the workforce for food safety management,
(b) To provide technical and practical knowledge enabling trainees to participate in HACCP development and implementation and
(c) To change the attitudes of people.

Training is a legal requirement by Council Directive 93/43/EC on the Hygiene of Foodstuffs. Annex X (Training) requires that "food business operators shall ensure that food handlers are supervised and instructed and / or trained in food hygiene matters commensurate with their work force". However, many Cypriot companies do not appear to appreciate this.

This problem, again, is more evident among small and medium businesses. These businesses lack the resources to provide training and may not be able to spare key staff. Thus success depends essentially on the drive and determination of individual managers and staff within the business (Route, 2000). Training and especially ongoing training for employees, who have been with the company for some time, proved to be more difficult than for new employees (McAloon, 2000). From personal communication with the participants of the Cyprus survey, it is clear that the training of food handlers in food hygiene / safety and the HACCP system is very basic, particularly among the small food businesses. Efforts should be made by the competent authority (Public Health Services of the Cyprus Ministry of Health) to raise the awareness of the importance of this training.

It is noted that even in the UK (where the Food Standards Agency was established because of public and political concerns about food safety) many small businesses remain unaware of the HACCP system or lack sufficient in-house knowledge training about the risks associated with their procedures to put in place or maintained effective HACCP based controls (Food Safety Authority of Ireland, 2001 and 2002).

6.1.2.3 Cost considerations

The availability of resources to cover the cost of the HACCP system is fundamental to succeed in its development, implementation and maintenance. This barrier is typically associated with the size of the business. Thus, large business is expected to find financial resources easier than medium or small businesses, which do not have sufficient resources to implement the HACCP system. Small businesses may prefer to invest in other areas to improve the quality or quantity rather than the safety of foodstuffs (Forsythe & Hayes, 1998).

6.1.2.4 Access to information on hazards

Technical references and data on microbiological, chemical – especially pesticide and heavy metal residues – and physical hazards are very important for the development and implementation of a successful HACCP system. However, food businesses may face problems in obtaining the scientific information necessary for developing sound hazard assessments or for identifying specific support to implement the HACCP system. Furthermore, data and statistics on food poisoning cases and other data are not readily available. In 2002 the Cyprus Ministry of Health has created a department for surveillance and documenting of certain diseases including foodborne diseases. Its success will depend on the co-operation from the public, the medical profession and other professionals in providing comprehensive and accurate information on incidents.

6.1.2.5 Infrastructure and facilities

Infrastructure and facilities are also important when developing and implementing a HACCP system. The infrastructure of a business includes the construction of the building and whether it satisfies the needs for the proposed work. The facilities include the equipment, the traffic flow patterns, the ventilation system, the waste disposal system and other prerequisites, which are necessary for the proper development and implementation of a successful HACCP system.

It is obvious that many of the existing premises or even premises under construction may face difficulties in implementing these prerequisites. As a result, the management of such businesses have a further burden to improve / repair these deficiencies in the first place and after that to develop and implement the HACCP system.

6.1.2.6 Language problems

Language is a major challenge to the successful implementation of the HACCP system in the Eastern Mediterranean Region. Translation from English into Greek can result in confusing the meaning of even the basic HACCP terms. However, this translation is unavoidable, although English is the main foreign language in the secondary private education system, the level of proficiency required for the HACCP system terminology is not achieved by the majority of employees in the food industry. On the other hand, in tourism the majority of catering staff speak and read English. Seasonal workers in Cyprus sometimes have very poor standard of English and may not know Greek.

6.2 What can be learnt that is new from this research

The objectives of this research have been set as a starting point and described in Chapter 1.1. This is the first research project in Cyprus in which the wide range of food businesses has been consulted for the purpose of hazard identification. The survey has raised awareness among the participating food businesses about the HACCP system. The author had the opportunity to visit all selected food businesses participated in this research and the recommendations are, therefore, based on first hand experience. A priority is to improve the knowledge of the people employed in the food sector and secondly to promote the wider implementation of the HACCP system. These recommendations are described in detail in the context of Cyprus in Chapter 7.

6.3 Whether full implementation of the HACCP system is essential for every food business or whether businesses could be categorised in terms of priority for implementation of the HACCP system

The benefits and the scope of a food safety management system are already discussed in previous Chapters. The author of this research believes that the application of the principles of the HACCP system is essential for every food business. An implementation strategy should be developed so as to give more help to the medium and small food businesses. Obviously, these businesses face the most difficulties in implementing the HACCP system. (See Chapter 6.1)

6.4 Could a stage approach be introduced for small businesses in particular?

As the funds for introducing the HACCP system are limited (see Chapter 7.2.1.1), the author of this work recommends a step by step approach for the HACCP system introduction for small businesses in contrast with the large / medium sized businesses. This approach will help to avoid unnecessary upheavals which small businesses can ill afford.

6.5 What are the relative roles of government, its inspectors, educators, private consultants and the businesses themselves in the process (stakeholders)

This study has identified that achieving a safe and wholesome food supply must be a shared responsibility among all stakeholders including government, industry and consumers. It is, therefore, of vital importance that each partner understands and carries out their responsibilities.

It is essential that the food industry sector is aware of the potential food hazards associated with the processes applied by the various businesses and the relevant regulatory requirements. In order to develop, implement and maintain an effective food safety management system these potential food hazards have to be eliminated.

A major role of government is to oversee the total food supply from production or harvesting to consumption (Tompkin, 2001). To achieve this, government should set, through food legislation, the necessary food safety standards. Such standards should be in accordance with those either developed by the Codex Alimentarius Commission or the European Union. Government should also provide assistance to the food sector in order to develop their individual food safety management programmes.

Food safety standards are the foundation for a food inspection programme, which is carried out by the competent authorities during their visits to the food businesses. The following should be taken into consideration:

- Establishment and enforcement of legislative or other measures to prevent future problems and
- Education of the food handlers at all levels in food hygiene matters.

As a result, the government's role changes from inspecting specific production lots and processing conditions for compliance on a specific day, to assessing the regulatory effectiveness of industry controls.

The consumer is the final stakeholder in the food chain in achieving food safety. Even if the food industry produces and delivers safe food products to consumers, they can pose safety problems if they handle them irresponsibly. Thus, the consumers have the right to be informed about food safety and to be given them instructions of proper handling of the food products. This is the responsibility of the food sector and the government

Specific measures recommended to be implemented by the food sector and the government and particularly in relation to the Cyprus context are described in Chapter 7.

6.6 Can the HACCP system be recognised more widely through a Rite mark system, which consumers can easily recognise as indicating good food quality? Are there other incentives?

The author has had personal communication with the competent authorities (Public Health Services of the Ministry of Health for the HACCP system and Ministry of Commerce, Industry and Tourism for the ISO quality systems) and other stakeholders (Cyprus Consumers Association and Chamber of Commerce and Industry) to investigate this matter. The outcome of these discussions is the confirmation that the label of a product can bear the information that the specific product has been produced in a business having the HACCP system or the ISO standard in place. This may give an advantage to these products because consumers will feel that the products are of better quality and safer than others. The author of this work is of the opinion that this market-based incentive will promote further the implementation of the HACCP system,ISOs among food businesses.

There is also a subsidisation scheme developed by the Ministry of Commerce, Industry and Tourism. The Ministry subsidises 15% of the total expenses of food businesses for the purchase of any new equipment during the HACCP system development and implementation.

Moreover, the Chamber of Commerce and Industry awards every year the "exportation prize". This prize is awarded to the business with the most exports. Having in mind that the majority of the European Union businesses require that the exporter has the HACCP system in place, it is obvious that this should also promote HACCP system implementation.

6.7 Further research needed

The term "zero risk" in food hygiene / safety is not achievable. However, it is generally possible to achieve progressive improvements in the food sector in the Eastern Mediterranean Region.

It has been recognised that changes in food production and marketing can lead to exposure to new risks and greater potential consequences of foodborne illness outbreaks (Unnevehr, 2002). On the other hand, consumers have become more aware of the potential food hazards through the increased scientific understanding and the greater media coverage. As a result, the scientific world is now required to react and suggest practicable measures to improve the food safety.

This includes the setting up of the European Food Safety Authority (Council Regulation 178/2002, 2002). This initiative should be followed by each of the EU Member States because the establishment of such an authority consolidates all food safety regulations.

Co-operation between different public health and food safety authorities is also emphasised in many countries and the concept of a total overview of the problems "from farm to table" is taking over (Schlundt, 1999). The European Union through legislative and other measures has established a unified approach for food safety issues. This helps the various Member States, which from the 1st May 2004 will reach a total number of 25, to co-operate and raise the standards further. As Cyprus is also joining the EU it is of vital importance that the local food safety issues are addressed promptly.

Jouve (2000) identified three areas that should be further enhanced in order to promote food safety. These are:

(a) The development of a risk-based food safety strategy by the governments. For the development and the establishment of this strategy, all stakeholders should be involved through the:
    - Determination of the requirements for food safety,
    - Development and use of specific procedures for risk analysis,
    - Monitoring of the implementation of any measures,
    - Assessment of their effectiveness,
    - Review of hazards and measures,

(b) The development of effective food safety management programmes and systems by food businesses operators and

(c) The recognition of the full potential of the HACCP system for ensuring food safety.

6.8 How do we apply the HACCP system across national borders? Should the HACCP system compliance be a requirement?

The HACCP system application is legally required by the European Union legislation. Council Directive 93/43/EEC only requires the implementation of the first five principles of the HACCP system thus excluding two principles i.e. the verification of the HACCP system and the documentation of all procedures. Cyprus has proceeded to the harmonisation of its legislation to this Directive with the Hygiene and Official Control of Foodstuffs Regulations of 2002 as described in Chapter 2.2.6.

Cyprus is at the eastern border of the EU and, therefore, has an important role in the Middle East region because of its economic co-operation with other Middle East countries. In this context, if the food safety standards in Cyprus are high enough, pressure can be put on these countries (or the co-operative food businesses) to promote higher quality standards.

6.9 The necessity of auditing of the HACCP system

Auditing is a fundamental part of any management system and should therefore be applied to the HACCP system. An audit can be defined as a "systematic evaluation of a system against a set of defined criteria" (Khandke, 2000).

Kvenberg *et al* (2000) identified among others the following goals of the HACCP system auditing from the competent authorities perspective:

- Make the food supply safer through prevention of food safety hazards,
- Enable them to more efficiently utilise their existing resources devoted to ensuring food safety and
- Enhance their ability to provide consumers with the assurance they seek that the food supply is safe.

A HACCP system audit is used to establish whether or not the controls, monitoring procedures and corrective actions defined in the HACCP plan are being applied correctly, and whether or not they are effective.

The auditing can be internal and / or external. The external auditing can include the auditing of suppliers or customers if the customers are responsible for distributing or selling the products. In the Cyprus survey, almost 60% of the businesses having the HACCP system in place proceeded to the external auditing of their systems.

The competent authorities should also carry out auditing of the HACCP systems to ensure that it is properly designed and implemented. Thus, they have both a strategic role in the implementation of the HACCP system as well as an operative role in organising the effective and ongoing assessment of the HACCP systems of the food sector (WHO, 1998b). In this respect, auditing of the HACCP systems can be done in two steps (Ababouch, 2000):

- Assessment of the HACCP manual which is basically a document review and
- An on-site verification to establish whether the "approved" HACCP manual is properly implemented.

In order to achieve public trust the role of the HACCP system auditing must be given increasing emphasis. This requires the setting of standardised auditing methods at an international level.

This work described the current status of HACCP in Cyprus and characterised the factors that affect its establishment in different parts of the food sector. A further issue for food businesses is to maintain and improve their standards as the businesses change their food production/catering procedures. Factors, such as introduction of genetically modified foods, exotic foods, new processing methods are among potential triggers for such a re-evaluation.

7 RECOMMENDATIONS FOR IMPLEMENTATION

One of the practical outcomes of the present work as referred in Chapter 1.2 is the identification of how to implement the HACCP system widely among food businesses in Cyprus. It has been identified that special emphasis must be given to the small and medium food businesses because of the difficulties they face to implement the HACCP system. Therefore, particular attention is given in these recommendations to such businesses.

These recommendations take into account the published literature on the subject.

7.1 Education and training

The results of the Cyprus survey clearly show that the respondents lack appropriate knowledge on food hygiene / safety and the HACCP system. Thus, in order to improve that knowledge, all people working in food businesses should be adequately educated and trained. Training is of vital importance for transmitting information and knowledge on food hygiene and safety to the food sector. A survey carried out in Kansas in 1997 among foodservice operators showed that a six-hours training on food hygiene / safety and the HACCP system was deemed acceptable by the employers (Barrett *et al*, 1998).

In this sense, the competent authority in Cyprus, which is the Department of Medical and Public Health Services of the Ministry of Health, should build a framework of training.

It is important to note that training starts with senior management and training initiatives should include training the managers, thereby winning their commitment to motivating and supporting their staff.

The training programmes benefit the businesses by (Sprenger, 2002):

- Assisting in the production of safe food,

- Safeguarding the quality of the product and reducing food wastage,
- Reducing complaints,
- Generating a pride in appearance and practices, increasing job satisfaction and probably reducing staff turnover,
- Contributing to increased productivity,
- Ensuring that all the correct procedures, including cleaning, are followed,
- Complying with the legal provisions or the requirements of industry guides or codes of practice, if any,
- Promoting a good company image, which should result in increased business and
- Promoting the supervisory skills of managers.

The training framework should be based on the following principles as suggested by the World Health Organisation (WHO, 1999):

- Training should lead to behavioural changes and not just focus on acquisition of knowledge,
- Training guidelines need to be adapted to the local requirements taking into account cultural and linguistic differences,
- Training should be tailored to the needs of the small and medium businesses, and is best carried out on-site or should be based on specific work-related examples,
- Flexible delivery of training should be considered, including distance learning, on-the-job training and recognition of prior experience,
- Training should be communicated / delivered at a level and in a manner appropriate to the target audience,
- Training material should conform with national legislation and standards, Codex Alimentarius requirements and, where appropriate, involve external certification of courses and / or teaching material,
- Completion of successful HACCP training should be associated with the appropriate motivational or reward framework; this may be linked to longer-term employment or promotional benefits or other staff retention strategies,
- Management must be seen to value training and owner / managers themselves should therefore be trained and supply all the facilities to fulfil training requirements,

- Training should not be considered a one-off event. It need updating and, if possible, maintenance of training logs and
- HACCP training should promote understanding, be interactive and build on existing food hygiene training or equivalent experience.

The ability of training providers crucially affects the quality of the food hygiene / safety and HACCP training (Williams *et al*, 2003). Therefore, registering the training providers will help the competent authority of Cyprus to set and monitor the standards of training provided to the food sector.

Furthermore, the competent authority should establish levels of training. Each training level will have different contents and duration. A similar training system has been established by organisations / institutions in the UK (e.g. the Royal Society for the Promotion of Health (RSPH), the Chartered Institute of Environmental Health – formerly the Institution of Environmental Health Officers (IEHO), the Royal Institute of Public Health and Hygiene (RIPHH), the Society of Food Hygiene Technology (SOFHT), and the Royal Environmental Health Institute for Scotland (REHIS)). Taking into account the levels of training delivered by other organisations / institutions abroad and the training needs of the food handlers and other employees in the food businesses derived from the personal communications of the author with the participants in this research, he suggests the following training levels for food hygiene and the HACCP system:

7.1.1 Food Hygiene Training

(a) Level 1: Introduction to Food Hygiene Course

This course is a three-hours course for new food handlers and other staff who are not food handlers. The trainees are not examined after the completion of the course.

(b) Level 2: Basic Food Hygiene Course

This course is a one-day (6 hours) course with a written examination at the end. It is delivered to food handlers and it provides general information on food hygiene issues such as microbiological, chemical and physical hazards, contamination of foods, safe preparation practices, spoilage and preservation, personal hygiene and cleaning and disinfection of premises and equipment.

(c) Level 3: Intermediate Food Hygiene Course

This course is a three days course (18 hours) with a written examination at the end. It is delivered to food handlers, supervisors and management people. It gives the information in a more detailed way, it includes the prerequisites of the HACCP system and also covers briefly the principles of the HACCP system.

(d) Level 4: Advanced Food Hygiene Course

This course is a five days course (30 hours) with an oral and written examination at the end. The participants of this course should first complete the Intermediate Food Hygiene Course. Food handlers, supervisors and management people can participate at this course. It is also suitable for supervisors for delivering in-house and on-site training. All subjects are covered more thoroughly and the course also involves practical training.

7.1.2 HACCP Training

(a) Level 1: The HACCP Principles Course

This course is a three days course (18 hours) and covers in details the 7 principles of the HACCP system and how these principles can be used by a food business to control potential food hazards. It also includes case studies and where possible visits to food businesses in which the HACCP system is in place. After the completion of the course, the participants should sit and successfully pass the written examination which includes the assessment of their knowledge on the HACCP system and on case study.

This course is suitable for food handlers, supervisors, management people and owners of small and medium food businesses. The participants however, should first attend successfully the Levels 3 and 4 of the Food Hygiene Training programme.

(b) Level 2: The Auditing of HACCP Course

The participants of this course should first successfully complete the Level 3 and 4 of the Food Hygiene Training and the Level 1 of the HACCP training. It is a five days course (30 hours) and is intended for supervisors, management people and owners of food businesses. The purpose of this course is to provide sufficient knowledge to the participants to carry out internal auditing in their businesses and external auditing to other businesses for example to their suppliers.

At the end of this course the participants should sit and successfully pass the written and oral examination.

After the successful completion of any of the above courses, except the Level 1 of the Food Hygiene Training, a Certificate is issued stating among others the level of the course attended.

Once the competent authority establishes the training framework as explained above, then there will be a coherent and similar training delivered to management of food businesses and food handlers.

7.2 Measures to facilitate the implementation of the HACCP system

The importance of the HACCP system for food businesses is explained in previous Sections of this work. However, its implementation level especially in the small businesses as revealed by the survey carried out in Cyprus is very low, thus, a series of measures are proposed and analysed for a wider implementation of the HACCP system.

7.2.1 External forces

7.2.1.1 Time schedule for the HACCP system implementation

Although the HACCP system is legally required by the Cyprus legislation to be implemented by all food businesses in Cyprus, the author based on the results of this work and the difficulties faced by food businesses, particularly by small ones, to implement the system, he proposes that its development and implementation is done in phases. Thus:

(a) Large businesses (more than 51 food handlers) are required to implement the HACCP system as soon as possible and in any way not later than the end of June 2004,

(b) Medium businesses (between 11 to 50 food handlers) are required to implement the HACCP system by the end of June 2005 and

(c) Small businesses (less than 10 food handlers) are required to implement the HACCP system by the end of June 2006.

The reasons for proposing the above time schedule are the following:

(a) The difficulties faced by medium and particularly small businesses in implementing the HACCP system as described in Chapter 6.1,

(b) The lack of knowledge and training among the management and food handlers on food hygiene / safety,

(c) The difficulties faced by the competent authority to adequately guide and help medium and small businesses due to:

i) The shortage of the number of personnel (Public Health Inspectors – Ministry of Health) (Anthousis Sofoclis 2003, personal communication),
ii) The large number of medium and small businesses established on the island,
iii) The short time of entering into force of the Regulations requiring the implementation of the HACCP system by all food businesses,

(d) The need to implement firstly the prerequisite programmes and establish Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) so as to be better prepared to implement the HACCP system.

7.2.1.2 Government commitment and establishment of good communication between the Government and the businesses

The Medical and Public Health Services of the Ministry of Health and the Public Health Services of the Municipalities are the competent authorities for applying the food legislation in Cyprus. As a result, these two Services have the responsibility to provide leadership in promoting and facilitating the implementation of the HACCP system.

It is important however, that the competent authorities should move from the current inspection procedure which was based on a traditional approach focused on snapshot inspections of the processing plant environment and comprehensive sampling and inspection of the final product (McEachern *et al*, 2000). The authorities are recommended to establish a new Inspection Framework which will be a risk-based approach, the objectives of which will be as follows:

(a) To allow a consistent and uniform inspection approach based on the risks associated to each business,
(b) To provide higher levels of food safety and consumer protection and
(c) To provide an effective and efficient food inspection system that is open and transparent to all stakeholders.

On the other hand good communication between the competent authorities and the businesses are of fundamental importance. Suwanrangsi (2000) suggested that a proactive and close collaboration and communication between businesses and government can really help in successful implementation of the HACCP system. For facilitating the above communication, the establishment of an information centre / office by the Ministry of Health is proposed. Otherwise means for communicating with the businesses should be developed. Such means may include the person-to-person communication, the use of the Internet and the publication of several educational brochures.

It should be noted that as the Medical and Public Health Services of the Ministry of Health and the Public Health Services of the Municipalities do not implement the HACCP system in food businesses. Therefore, the author proposes the following support to be given to the food businesses by the competent authorities (Medical and Public Health Services of the Ministry of Health and Health Services of the Municipalities):

(a) Information and other support for establishing the prerequisite programmes before the implementation of the HACCP system,
(b) Consistent information on the benefits and principles of the HACCP system including cost savings,
(c) Information on and funding for accredited training courses. The Human Resource Development Authority of Cyprus is funding part of the costs of accredited training courses delivered by external consultants and other governmental bodies. This should be extended and cover small businesses and particularly design and implement on-site or off-season training schemes to allow broader participation,
(d) Information on external consultants,
(e) Training materials for the HACCP system,
(f) Information on international standards,
(g) Advice on hazards analysis and
(h) Adequate inspection staff to give the necessary on site advice.

7.2.1.3 Industry and Trade Associations to develop Industry and Trade guides to Good Hygiene Practices and Good Manufacturing Practices

The Industry and Trade Associations should co-operate with other stakeholders such as business operators, the competent authorities and consumer groups such as the Cyprus Consumers Association to propose such measures and establish such programmes so as to facilitate the application of the food legislation in general and the HACCP system in particular. Small businesses are members of these associations and, therefore, they should seek such co-operation which it is believed to be very beneficial.

Furthermore the Hygiene and the Official Control of Foodstuffs Regulations of 2002 state that guides to Good Hygiene Practices and Good Manufacturing Practices could be developed with the aid of the Cyprus Chamber of Commerce, the Cyprus Consumer Association and other interested parties.

7.2.1.4 Raising consumers' awareness

Consumers have a growing interest in food safety especially as food safety and health trend information is now readily accessible and available (WHO, 2001). Thus, the communication to the consumers of information on the HACCP system is an indirect way of rising up the general public awareness about the HACCP system. Furthermore, consumer representatives like the Cyprus Consumer Association should play a more active role and assist general consumer understanding food safety issues, including those associated with the application of the HACCP system. This can be done through the involvement of a larger number of consumers in this Association and, particularly, of different disciplines scientists in order to have a broader and more comprehensive involvement in the food safety issues of Cyprus.

This increased general awareness will then positively change their opinion about the necessity of the implementation of HACCP system in the food businesses. As a consequent and taking into account that food handlers and other people working in food businesses are consumers as well, it is obvious that this change will positively influence them to understand the need to implement the HACCP system.

The Cyprus Consumer Association as stated in Chapter 7.2.1.3 is also invited and with the co-operation of other bodies to develop guides to Good Hygiene Practices and Good Manufacturing Practices to be used by food businesses.

7.2.1.5 Technical support

The food businesses should have access to the necessary technical external support. This support includes:

(a) Access to low cost analytical services,

(b) Availability of sector-specific generic guidance to businesses, such as industry guides and other information on hazards by kind of food business and risk analysis in each case which should be developed by the Industry and Trade Associations and

(c) Access to collected epidemiological data of established and well-maintained foodborne disease surveillance programmes without any economic burden. Such programmes are now under development and will be maintained by the Medical and Public Health Services.

The above support should be given by the competent authorities, by the Chamber of Commerce and Industry, other trade associations and the Cyprus Consumer Association.

7.2.1.6 Incentives for small businesses

As small businesses face the most difficulties in developing and implementing a food safety management system like HACCP, additional incentives should be given to them. The author of this work proposes the competent authority (Ministry of Health) to implement the following measures:

(a) Promote further the Rite mark approach,

(b) Provide additional assistance by the Public Health Inspectors and, especially, in conducting a hazard analysis, determining the critical control points and establishing the critical limits,

(c) Provide financial assistance through a subsidisation programme apart from the subsidisation currently given by the Ministry of Commerce, Industry and Tourism. This subsidisation should be given only if the HACCP system is audited successfully by the competent authority or other external accredited by the competent authority auditors. Efforts of the competent authority should be driven to establish an inexpensive auditing programme so as to minimise its costs. This subsidisation level should be based on the Government budget.

7.2.2 Internal measures

7.2.2.1 Implementation of the prerequisite programmes of the HACCP system

The prerequisite programmes of the HACCP system and their importance are mentioned in Chapters 2.3.1 and 2.5.1. Their implementation will be a strong foundation of the HACCP system and will help the businesses HACCP Teams to develop and implement it. Furthermore, having in place the prerequisite programmes, the number of Critical Control Points will be lower, thus allowing a better maintenance of the HACCP system and minimising the possibility of loosing control.

7.2.2.2 External consultants

It has been shown from the results of the Cyprus survey and Crete study (Chapters 4.1.9.1 and 5.1.8) that the great majority of food businesses that had the HACCP system in place developed and implemented it with the help of external consultants. The selection of the external consultant is very important and, therefore, the Ministry of Health should provide the food businesses with necessary guidelines and information to assist them in finding an external consultant. Furthermore, the

Ministry of Health should communicate to the businesses information determining the level of needs and requirements from them. These needs should then be consulted when the management of the food businesses will select the external consultant. In this process, the consultants' qualifications should be assessed taking into account their:

- Experience,
- Professional history,
- Familiarity with the size of the business,
- Familiarity with the type of the business and the processes followed and
- Interest to meet the needs and requirements of the business.

7.3 Establishment of an Action Plan

For the above recommendations an Action Plan needs to be established although all measures if implemented as soon as possible would enhance food businesses in Cyprus to establish a food safety management system and particularly the HACCP system. Therefore, the following Action Plan for the above recommendations is proposed by the author of this work:

(a) For the training scheme, this should be put into practice as soon as possible taking into particular consideration the difficulties of small businesses to attend such training,

(b) The prerequisites of the HACCP system should be implemented by all food businesses without delay so as to give a strong foundation for implementing the system,

(c) The time schedule of the HACCP system implementation is also strongly recommended and, therefore, should be introduced by the Ministry of Health as soon as possible,

(d) The introduction of the Inspection Framework will take some time because of the changes that should be made within the competent authority and mainly within the Public Health Services. From the personal communication of the author, it is believed that there is a change of the basis of the inspection system in Cyprus, thus this change should be progressively enhanced,

(e) The competent authority should develop and communicate the informative material on the HACCP system (technical support and information for selecting a consultant) by the end of 2003 and

(f) The industry guides should be developed, approved by the Minister of Health and communicated to all food businesses by the end of June 2004.

8 CONCLUSIONS

Food safety has wide ranging public health implications. In this context there are many issues, which have been to be considered to protect the interests of consumers and meet their needs for advice and information.

For the East Mediterranean Region these issues have become more urgent in view of the forthcoming accession of Cyprus to the European Union. There is a need for the Cyprus Government to ensure an adequate food safety system in terms of resources, management and monitoring.

This research has focused on the state of development and implementation of the HACCP system in Cyprus. The questionnaire based survey covered almost 7% of the total number of food businesses in Cyprus. The majority of respondents (55%) were employees and the remainder were owners.

Owners were found to have the lowest level of education of the respondents, as 67.4% have only Lyceum leaving certificate. This is due to the fact that most of them (64.4%) are older than 40 and they did not enjoy the opportunities currently available in Cyprus.

The level of general education of respondents who were not the owner was higher, as most of them possessed a Diploma or University Degree. Currently, the competition for such positions ensures that education, knowledge, and experience in the field are of high levels.

The results clearly showed that respondents were not fully aware of the risks involved in their type of industry and the categorization of their business in relation to these risks.

The results suggest that respondents did not recognise microbiological hazards that were significant to their products and processes. Among the listed microbiological hazards, Salmonella was categorised as "high risk" by the highest percentage of respondents. It reflects the fact that a lot of publicity was given by mass media to Salmonella food poisoning incidences in Cyprus.

As regards the chemical hazards, half of the respondents did not consider them as hazards.

Physical hazards were classified more frequently than chemical hazards as "high level" risk but less frequent than microbiological ones. On the other hand, respondents from catering businesses were the least aware of these hazards. The awareness of these hazards by respondents from the food industry was not as high as that of respondents from catering businesses.

However, this was not the case as only 16.4% of respondents assessed their businesses' in terms of food safety as high level.

The responses given from the respondents of the high-risk industries showed that there was only a very basic understanding of hazard severity as only 21.3% of them acknowledged the listed hazards as "high level".

From the results, a high percentage of businesses seemed to check the raw materials at the time of the delivery. Indeed, the persons responsible for the deliveries in almost all food businesses were very careful when receiving the raw materials. Beyond the risks to public health of possible use of unsuitable raw materials for human health, receiving of such materials may lead to economic losses, a fact that appears to be well recognised in Cyprus.

The role of microbiological testing is of particular interest, although this is a practice which is carried out infrequently in the surveyed businesses. Three quarters of hotels in this survey carried out microbiological testing every month.

The great majority of businesses in the Cyprus survey checked and reviewed the written guidelines every 6 to 12 months, an interval which can be considered as satisfactory assuming that there are not any changes which need immediate alterations of the guidelines.

Almost half of businesses in the survey ensured the safety of food using their common sense and experience. However, common sense and experience differs from person to person, and this "system" cannot be used to verify its effectiveness for production of safe food.

As might be expected, the size of the business is an important factor for the application of a suitable and effective food safety / quality system. Thus, smaller businesses are less likely to have a food safety / quality system in place due to financial and other pressures.

However, the percentage of the medium-sized businesses applying a suitable system to ensure the production of safe food rose up to 46% and for the large businesses it was even bigger reaching the 75%. This means that larger businesses were more likely to have a food safety / quality system in place.

In-house designed hygiene systems were used in a higher percentage in medium-risk than in low and high-risk types of the food industry. ISO (the ISO 9000 series) was applied in a higher number of low and medium-risk types of the food industry than high-risk ones.

It was found that the level of education of the respondents have a significant effect on their appreciation of level of hazards.

The results of this cross-tabulation indicated a positive correlation between the size of business and the existence of the listed hygiene practices. Businesses employing more food handlers were much more likely (steady increase of the percentage) to have these practices in place. This also showed that larger businesses were more aware of the importance of these practices.

The HACCP system was known by only 55% of the respondents. Public Health Inspectors and external consultants took the lead for communicating information / knowledge to food businesses about the HACCP system. Another source of information is training courses provided by Colleges and Universities. One fifth of respondents obtained knowledge regarding the system by attending seminars. As regards the Internet, the general problem is that it is not accessible to all people working in food businesses. This is the reason of the low percentage of respondents who claimed that they received information on the system when using the Internet.

The implementation of the HACCP system is the target of food regulatory authority in every country and of course the same happens in the case of Cyprus. This survey showed that the implementation level of the HACCP system was 17%.

There was a wide range of percentages and it is clear that the geographical region and the time of the survey influenced the results. However, in the case of Cyprus, the implementation levels were lower than in other European countries, especially UK and Ireland. Almost 10% of the total economically active population is employed in this sector. Furthermore, a total number of 2.7 millions of tourists visited Cyprus in 2001 (Statistical Service of the Republic of Cyprus, 2001).

23.5% of the respondents from the businesses having the HACCP system in place replied that they implemented the system because of the impending legal requirement.

The establishment of a HACCP board under the Government auspices could be very beneficial but respondents did not consider it as a major source of help.

Respondents were of the opinion that the use of the Internet to seek information on the HACCP system was of limited importance to them.

As expected, the level of implementation of the HACCP system was positively correlated with the size of food businesses. The results of this cross-tabulation clearly showed that as the number of food handlers increased in a business, the chances of this business of applying the system also increased.

There was a direct effect of the years of operation of the businesses and the implementation level of the HACCP system. The percentage of businesses which had the system in place and operating for up to 15 years decreased as the years of operation increased.

On the other hand, well-established (over 16 years of operation) were again more likely to have the HACCP system in place.

Small businesses in Crete followed more often the "common sense and experience" and "in-house designed hygiene" systems than the ones in the Cyprus survey.

As regards the medium businesses, quality standards were better implemented. 62.5% of them applied ISO, in contrast to the Cyprus survey where only 36.1% of them implemented it.

As regards the "not a hazard" responses, the correlation was the same as the "high level" responses on the microbiological hazards. This means that less College and University graduates than non-graduates characterised the listed hazards as not hazardous to public health.

There is a positive correlation between the size of business and the existence of the listed hygiene practices, particularly for small and medium businesses. Moreover, the tendency was observed in the Cyprus survey.

86% of respondents from the Crete study were aware of the HACCP system.
Other businesses were the best source of information about the HACCP system.

External consultants were the second most frequently selected source of information on the HACCP system. These results are lower than the Cyprus survey but higher than that of the survey, carried out in UK by Panisello *et al* (1999).

The Crete survey showed that the implementation level of the HACCP system was 44%. The years of operations of the businesses did not have any effect on the number of businesses within the specified categories which implemented the HACCP system. Half of surveyed businesses implemented HACCP were externally audited.

Half of respondents (three quarters were from hotels) believed that the system would cost up to 17000 Euros. It seems that food businesses in Crete were more aware of the costs involved for the development and implementation of the HACCP system than those in Cyprus.

The results of the Cyprus survey clearly show that the respondents lack appropriate knowledge on food hygiene / safety and the HACCP system.

PART A

CYPRUS SURVEY

Kind of food business		Number of registered businesses	Number of businesses visited
A. Food Industry			
1	Soft drinks, juices and syrups	31	5
2	Flour-mill	6	6
3	Meat products	109	9
4	Bakeries	348	25
5	Dairies	43	5
6	Bottling of seedoil and margarine	5	5
7	Water bottling	14	5
8	Dry nuts, tahini and halva	30	5
9	Confectioneries – sweets and chocolates	124	10
10	Ice cream	34	5
11	Coffee	5	5
12	Canning	6	5
13	Pasta	16	5
14	Alcohol and spirit	46	5
15	Catering	5	5
16	Various	292	20
	Total A	1114	125
B. Catering businesses			
Restaurants (including take away restaurants), taverns and pizzas		2786	135
C. Hotels with restaurants and B/B Accommodation		430	30
	Total (A+B+C)	**4330**	**300**

PART B

CRETE STUDY

Kind of food business		Number of registered businesses	Number of businesses visited
A. Food Industry			
1	Water bottling	78	1
2	Flour-mill industries and pasta	8	0
3	Meat products	24	3
4	Bakeries and confectioneries	330	4
5	Dairies (including dairy products industry)	43	1
6	Bottling of olive oil and olive	136	0
7	Ice cream	6	2
8	Coffee	20	0
9	Canning	12	1
10	Various	14	2
11	Fish	5	2
	Total A	677	16
B. Catering businesses			
Restaurants (including take away restaurants), taverns and pizzas		708	15
C. Hotels with restaurants and B/B accommodation		450	19
	Total (A+B+C)	**1835**	**50**

PART A

CYPRUS FOOD HYGIENE SURVEY

(PILOT SURVEY)

PART A

1. Your age and gender

Under 20 years old	☐		
Between 20-30 years old	☐	Male	☐
Between 30-40 years old	☐		
Between 40-50 years old	☐		
Between 50-60 years old	☐	Female	☐
Over 61 years old	☐		

2. What is your position in the business?

Owner of the business	☐	Chef	☐
Manager	☐	Production line supervisor	☐
Other (Specify) ________________________			

3. For how many years do you have this position in this business?

Less than 1 year	☐	Between 4-5 years	☐
Between 2-3 years	☐	More than 6 years	☐

4. For how many years all together do you work in the food/catering industry?

Less than1 year	☐	Between 4-5 years	☐
Between 2-3 years	☐	More than 6 years	☐

5. What is your level of education on food hygiene/food safety?

Unqualified (Lyceum leaving certificate)	☐	Intermediate (Food hygiene courses)	☐
Basic (Induction training)	☐	Advanced (College/University degree)	☐

6. For how many years has your business operated?

Less than 2	☐	Between 6-10	☐
Between 3-6	☐	More than 10	☐

7. What is the main function of your business?

Hotel	☐
Restaurant / Take away	☐
Food manufacturing/processing industry	☐

PART B

8. a) What kinds of products are handled in your business and b) what main process(es) you employ?

A) Kind of products		B) Process(es)	
Cooked meats	☐	Unprocessed (raw)	☐
Raw meats	☐	Canned	☐
Ready made sandwiches	☐	Chilling / Freezing	☐
Cooked poultry	☐	Drying	☐
Raw poultry	☐	Frying	☐
Dairy products	☐	Roasting	☐
Egg/cream cakes	☐	Boiling	☐
Cooked rice	☐	Baking	☐
Cooked fish	☐	Pasteurising	☐
Raw fish	☐	Sterilising / Retorting	☐
Chilled ready meals	☐	Fermenting / Acidifying	☐
Egg products (mayonnaise)	☐	Curing / Salting / Smoking	☐
Other (Specify) ______________		Other (Specify) ______________	

9. What do you consider to be the hazards to public health imposed by the products handled in your business and how important are they?

	High level	Medium level	Low level	Do not know
A) Microbiological hazards (e.g.)				
• Salmonella	☐	☐	☐	☐
• Staphylococcus	☐	☐	☐	☐
• E.coli	☐	☐	☐	☐
• Campylobacter jejuni	☐	☐	☐	☐
• Clostridium botulinum	☐	☐	☐	☐
B) Chemical hazards (e.g.)				
• Mycotoxins	☐	☐	☐	☐
• Agricultural chemicals	☐	☐	☐	☐
• Food additives	☐	☐	☐	☐
• Metals	☐	☐	☐	☐
• Veterinary residues	☐	☐	☐	☐
C) Physical hazards (e.g.)				
• Pieces of metals, stones, glass, plastic, bones)	☐	☐	☐	☐

10. How many of your staff is involved in food handling in your business?

Less than 2	☐	Between 6-10	☐
Between 3-5	☐	More than 11, specify	____________

11. Does the business employ temporary food handlers to assist at busy times of the year? (June-August, Weekends, Public Holidays)

Yes	☐	No	☐

12. Please indicate the number of your staff qualified in food hygiene/food safety at each of the following levels.

(For each member give only the most recent/advanced qualification)

	Total number of staff	Not trained	Basic/ Induction training	Intermediate Food hygiene and refresher courses	Advanced/ College, University degree
Full-time Food handlers	_____	_____	_____	_____	_____
Temporary food handlers	_____	_____	_____	_____	_____
Managers/ Supervisors	_____	_____	_____	_____	_____

13. Who provides the food hygiene training for your staff?

	Initial training	Refresher courses	Advanced courses
In House staff	☐	☐	☐
Health Inspectors of the Ministry of Health	☐	☐	☐
Officers from the Ministry of Agriculture	☐	☐	☐
Other (Specify)	_______	_______	_______

14. Which of the following quality assurance systems is applied in your business?

ISO	☐	
Good Manufacturing Practices (GMP)	☐	
Total Quality Management (TQM)	☐	
Standard Sanitary Operation Procedures (SSOP)	☐	
None	☐	**Please continue to question 16**
Other (Specify) ______________________		

15. If the business operates such a quality assurance system, a) when did it start and b) when was it accredited?

	Starting	Accreditation
In 2000	☐	☐
In 1999	☐	☐
In 1998	☐	☐
In 1997	☐	☐
Other (Specify)	________	________

16. Which of the following good hygiene practices are carried out by your business and how often are they carried out?

	Never	Once a day	Once a week	Once a month
Cleaning schedules	☐	☐	☐	☐
Stock rotation	☐	☐	☐	☐
Temperature monitoring of foods	☐	☐	☐	☐
Temperature monitoring of equipment	☐	☐	☐	☐
Microbiological testing	☐	☐	☐	☐
Inspection of raw materials	☐	☐	☐	☐
Checking/recording health/illness of staff	☐	☐	☐	☐
Reviews of good hygiene practices because of new products or suppliers	☐	☐	☐	☐
Periodic checks that the hygiene policy is working	☐	☐	☐	☐

17. Are there written guidelines provided by your business for carrying out these practices?

	Yes	Not now	In the future	Never
Cleaning schedules	☐	☐	☐	☐
Stock rotation	☐	☐	☐	☐
Temperature monitoring of foods	☐	☐	☐	☐
Temperature monitoring of equipment	☐	☐	☐	☐
Microbiological testing	☐	☐	☐	☐
Inspection of raw materials	☐	☐	☐	☐
Checking/recording health/illness of staff	☐	☐	☐	☐
Reviews of good hygiene practices because of new products or suppliers	☐	☐	☐	☐
Periodic checks that the hygiene policy is working	☐	☐	☐	☐

PART C

18. Do you know what the Hazard Analysis and Critical Control Point (HACCP) system is?

Yes ☐	No ☐	**Please continue to PART E**

19. Where did you obtain knowledge regarding the HACCP system?

Trade journal	☐	Public Health Officers	☐
External consultants	☐	Internet	☐
Colleges and Universities	☐	Other (Specify) ____________________	

20. Is HACCP already in use?

If yes, in which year did you first apply it? ____________	No ☐	**Please continue to PART D**

21. How did you implement HACCP?

With the aid of the government	☐	On your own	☐
With the aid of external consultants	☐	Other (Specify) ____________	

22. How long did the implementation of the HACCP system take?

1-3 months	☐	10 months -1 year	☐
4-9 months	☐	Other (Specify) ____________	

23. Give the reasons why HACCP has been applied in your business (You may choose more than one answer).

To increase the security and safety of your business	☐
Due to customer pressure	☐
Due to impending legal requirements	☐
Having confidence in your product	☐
To move accordingly to new trends or to give a commercial advantage	☐
Other (Specify)	____________

24. Is there a team responsible for the development, application and inspection of the HACCP system?

Yes	☐
No	☐

25. Did the team undergo formal training before the development and implementation of the HACCP system?

Yes	☐
No	☐

26. Does your HACCP system follow closely the documents of international bodies?

Yes	☐
No	☐

27. Is there external auditing for the HACCP system in place?

Yes	☐
No	☐

28. Did the HACCP system have been inspected / audited by the government and if so when?

If yes, when ___________	
No	☐

29. Do you have HACCP training programme for your staff particularly your new staff?

Yes	☐	No	☐	In the future	☐

Continue to PART E

PART D

30. Give the reasons of not having the HACCP system implemented in your business at present.

It is not required for the type of process	☐
Nobody knows about HACCP in the company	☐
There is no legal obligation of implementing HACCP	☐
It is difficult to apply in a business of your size	☐
It is difficult to apply in this sector	☐
It costs too much money	☐
Other (Specify)	___________

31. Are you planning to implement HACCP, if so when are you developing it?

This year	☐	In two years time	☐
Next year	☐	After three years	☐
Not at all unless it is a legal requirement ☐			

PART E

32. It is easy to get information on HACCP.

Strongly agree	☐	Disagree	☐
Agree	☐	Strongly disagree	☐
Neither agree/disagree	☐		

33. In your opinion what should be done to improve knowledge of HACCP?

Visits at the business from government agencies	☐	Seminars from private experts/consultants	☐
Seminars under the auspices of the government	☐	Other (Specify) ________________	

34. What actions are taken by your business when a complaint is made about food hygiene/food safety?

	Always	Sometimes	Rarely	Never
Answer back to the complainer	☐	☐	☐	☐
Only recording	☐	☐	☐	☐
Action inside the business-changes in production process	☐	☐	☐	☐
No action	☐	☐	☐	☐

35. How often does the Public Health Inspector visit your business for inspection purposes?

Not yet inspected	☐	Once a month	☐
Once a week	☐	Once every three months	☐
Twice a year	☐	Other (Specify)	________________

PART B

CYPRUS FOOD HYGIENE SURVEY

PART A

1. (a) Age		**(b) Position in the business**	
Under 19 years old	☐	Owner of the business	☐
Between 20-29 years old	☐	Manager	☐
Between 30-39 years old	☐	Chef	☐
Between 40-49 years old	☐	Production line supervisor	☐
Between 50-59 years old	☐	Other ____________________	
Over 60 years old	☐		

2. Please specify, what of the following you have:

School Leaving Certificate	☐	BSc/BA	☐	Others
Diploma	☐	MSc/MA/MBA	☐	____________

3. For how many years has your business operated?

____________ years

4. What is the main function or functions of your business?

Hotel	☐	
Restaurant/Take away	☐	
Food manufacturing/processing industry	☐	Specify ____________________

PART B

5(a). Hotels and Restaurants/Take Away and Manufacturing/Processing Industry		**5(b). Food Manufacturing / Processing Industry only**	
What kinds of products are handled in your business?		**What are the main processes employed in your business?**	
a) Kind of products		b) Processes	
Meat and Meat products	☐	Canned	☐
Poultry and Poultry products	☐	Chilling/Freezing	☐
Dairy and Dairy products	☐	Drying	☐
Fish	☐	Roasting Frying Boiling	☐
Rice	☐	Baking	☐
Bakery / Confectionery products	☐	Pasteurisation	☐
Drink/Juices	☐	Curing/Salting/Smoking	☐
Other (Specify) ____________________		Other (Specify) ____________________	

6. **How many of your staff are involved in food handling in your business and how many of them posses valid Health Certificate?**

Number of full-time food handlers	________	Valid Health Certificate	_________
Number of temporary food handlers (Weekends, Public Holidays)	________	Valid Health Certificate	_________

7. **How often does the Public Health Inspector visit your business for inspection purposes?**

Never	☐	Three times a year	☐
Once a year	☐	Four times a year	☐
Twice a year	☐	Other (Specify) ______________________________	

8. What do you consider the hazards to public health imposed by the products handled in your business and how important are they?

	High level	Medium level	Low level	Not a hazard
a) Microbiological hazards				
• Salmonella	☐	☐	☐	☐
• Staphylococcus	☐	☐	☐	☐
• E.coli	☐	☐	☐	☐
• Campylobacter jejuni	☐	☐	☐	☐
• Clostridium botulinum	☐	☐	☐	☐
• Spoilage organisms (moulds, yeasts)	☐	☐	☐	☐
b) Chemical hazards				
• Mycotoxins	☐	☐	☐	☐
• Agricultural chemicals	☐	☐	☐	☐
• Food additives	☐	☐	☐	☐
• Veterinary residues (Antibiotics, hormones)	☐	☐	☐	☐
c) Physical hazards				
• Pieces of metals, stones, glass, plastic, bones	☐	☐	☐	☐

Only for "High level" responses

You consider these hazards as high level because:	
You heard that they are high level hazards	☐
You know that they are high level hazards	☐
You were warned by the Health Inspectors that they are high level hazards	☐
There was a food poisoning case in your business	☐
There was a food poisoning case in another business	☐
Other (Specify) ______________________________	

Only for "Not a hazard" responses

You do not consider them as hazards because:	
You heard that they are not hazards	☐
You know that they are not hazards	☐
Nobody told you that they are hazards	☐
They are very small and invisible	☐
Other (Specify) ______________________	

9. Which of the following good hygiene practices and how often are carried out by your business?

	No	Yes	Frequency
Cleaning schedules for the premises and the equipment	☐	☐	__________
Inspection of raw materials	☐	☐	__________
Temperature monitoring of equipment (i.e. refrigerator, freezer)	☐	☐	__________
Microbiological testing of food	☐	☐	__________

10. Are there written guidelines provided by your business for carrying out these practices?

	Yes	Issued by	No
Cleaning schedules for the premises / equipment	☐	__________	☐
Inspection of raw materials	☐	__________	☐
Temperature monitoring of equipment (i.e. refrigerator, freezer)	☐	__________	☐
Microbiological testing of food	☐	__________	☐

11. How often are these guidelines checked and reviewed?

Every 6 months	☐	Every 2 years	☐	Other (Specify):
Every year	☐	Never	☐	____________

12. Which of the following systems is applied in your business to assure food safety?

Common sense and experience	☐	GMP (Good Manufacturing Practices)	☐
In-house designed hygiene systems	☐	None	☐
ISO	☐	Other (Specify)____________	

PART C

13. HACCP is:

Irradiation technique to eliminate pathogenic microorganisms	☐
Kind of equipment	☐
Kind of food	☐
Risk management system applied in the food businesses	☐
Do not know	☐

14. Where did you obtain knowledge regarding HACCP?

External consultants	☐	Public Health Officers	☐
Colleges and Universities	☐	Internet	☐
Other businesses	☐	Other (Specify) ____________	

15. Is the HACCP system already in use?

If yes, in which year did you first apply it? ____________	If No ☐	**GO TO PART D**

16. How did you implement HACCP?

With the aid of the government	☐
With the aid of external consultants	☐
On your own	☐
Other (Specify) ______________________________	

17. Give the reasons why HACCP has been applied in your business.

To increase the safety of food produced in the business	☐
Due to customer pressure	☐
Due to impending legal requirements	☐
To give a commercial advantage to the products of the business	☐
Other (Specify) ______________________________	

18. Has your HACCP been audited externally; and if yes, by whom?

If yes, by:		No ☐
Government	☐	
International Organisations	☐	
Private consultants / auditors	☐	
Others (Specify)______________________________		

19. In your opinion what should be done to improve knowledge of HACCP?

Seminars from governmental agencies	☐
Seminars from private experts/consultants	☐
Publications from the Ministry of Health	☐
Use of internet	☐
Others (Specify)______________________________	

PART D

20. Give the reasons of not having the HACCP system implemented in your business at present.

It is not required for the type of process / business	☐
Nobody knows about HACCP in the company	☐
There is no legal obligation of implementing HACCP	☐
It costs too much money	☐
Other (Specify)	____________________

Only for the answer "It costs too much money"

How much do you think it will cost?	________________	Pounds

21. Are you planning to implement HACCP, if so when?

This year	☐	In two years time	☐
Next year	☐	After three years	☐

PART C

CRETE FOOD HYGIENE STUDY

PART A

1. (a) Your age		**(b) Your position in the business**	
Under 19 years old	☐	Owner of the business	☐
Between 20-29 years old	☐	Manager	☐
Between 30-39 years old	☐	Chef	☐
Between 40-49 years old	☐	Production line supervisor	☐
Between 50-59 years old	☐	Other ________________	
Over 60 years old	☐		

1. Please specify, what of the following you have:

School Leaving Certificate	☐	University Degree	☐	Others
Degree of a Technical Educational Institution (TEI)	☐	Postgraduate Degree	☐	________________

2. For how many years has your business operated?

________________ years

4. What is the main function or functions of your business?

Restaurant/Take away	☐	
Hotel	☐	
Food manufacturing / processing industry	☐	Specify ________________

PART B

5(a) Hotels and Restaurants/Take Away and Manufacturing/Processing Industry		**5(b) Food Manufacturing/ Processing Industry only**	
What kinds of products are handled?		**What are the main processes employed?**	
a) Kind of products		b) Processes	
Meat and Meat products	☐	Canned	☐
Poultry and Poultry products	☐	Chilling/Freezing	☐
Dairy and Dairy products	☐	Drying	☐
Fish	☐	Roasting Frying Boiling	☐
Rice	☐	Baking	☐
Bakery / Confectionery products	☐	Pasteurisation	☐
Drink/Juices	☐	Curing/Salting/Smoking	☐
Other (Specify) ____________________		Other (Specify) __________________	

8.1 How many of your staff are involved in food handling in your business and how many of them posses valid Health Certificate?

Number of full-time food handlers	_______	Valid Health Certificate	_______
Number of temporary food handlers (Weekends, Public Holidays)	_______	Valid Health Certificate	_______

8.2 How often does the Public Health Inspector visit your business for inspection purposes?

Never	☐	Three times a year	☐	Twice a year	☐
Once a year	☐	Four times a year	☐	Other (Specify) _______________	

8. What do you consider the hazards to public health imposed by the products handled in your business and how important are they?

	High level	Medium level	Low level	Not a hazard
a) Microbiological hazards				
• Salmonella	☐	☐	☐	☐
• Staphylococcus	☐	☐	☐	☐
• E.coli	☐	☐	☐	☐
• Campylobacter jejuni	☐	☐	☐	☐
• Clostridium botulinum	☐	☐	☐	☐
• Spoilage organisms (moulds, yeasts)	☐	☐	☐	☐
b) Chemical hazards				
• Mycotoxins	☐	☐	☐	☐
• Agricultural chemicals	☐	☐	☐	☐
• Food additives	☐	☐	☐	☐
• Veterinary residues (Antibiotics, hormones)	☐	☐	☐	☐
c) Physical hazards				
• Pieces of metals, stones, glass, plastic, bones	☐	☐	☐	☐

Only for "High level" responses

You consider these hazards as high level because:	
You heard that they are high level hazards	☐
You know that they are high level hazards	☐
You were warned by the Health Inspectors that they are high level hazards	☐
There was a food poisoning case in your business	☐
There was a food poisoning case in another business	☐
Other (Specify) ____________________	

Only for "Not a hazard" responses

You do not consider them as hazards because:	
You heard that they are not hazards	☐
You know that they are not hazards	☐
Nobody told you that they are hazards	☐
They are very small and invisible	☐
Other (Specify) ____________________	

9. Which of the following good hygiene practices and how often are carried out by your business?

	No	Yes	Frequency (i.e. daily, weekly, monthly)
Cleaning schedules for the premises and the equipment	☐	☐	____________
Inspection of raw materials	☐	☐	____________
Temperature monitoring of equipment (i.e. refrigerator, freezer)	☐	☐	____________
Microbiological testing of food	☐	☐	____________

10. Are there written guidelines provided by your business for carrying out these practices?

	Yes	Issued by	No
Cleaning schedules for the premises / equipment	☐	____________	☐
Inspection of raw materials	☐	____________	☐
Temperature monitoring of equipment (i.e. refrigerator, freezer)	☐	____________	☐
Microbiological testing of food	☐	____________	☐

11. How often are these guidelines checked and reviewed?

Every 6 months	☐	Every 2 years	☐	Other (Specify)
Every year	☐	Never	☐	____________

12. Which of the following systems is applied in your business to assure food safety?

Common sense and experience	☐	GMP (Good Manufacturing Practices)	☐
In-house designed hygiene systems	☐	None	☐
ISO	☐	Other (Specify)____________	

PART C

13. HACCP is:

Irradiation technique to eliminate pathogenic microorganisms	☐
Kind of equipment	☐
Kind of food	☐
Risk management system applied in the food businesses	☐
Do not know	☐

14. Where did you obtain knowledge regarding HACCP?

External consultants	☐	Public Health Officers	☐
Colleges and Universities	☐	Internet	☐
Other businesses	☐	Other (Specify) ____________	

15. Is the HACCP system already in use?

If yes, in which year did you first apply it? ______	If No	**GO TO PART D**

16. How did you implement HACCP?

With the aid of the government ☐
With the aid of external consultants ☐
On your own ☐
Other (Specify) ____________________

17. Give the reasons why HACCP has been applied in your business.

To increase the safety of food produced in the business ☐
Due to customer pressure ☐
To give a commercial advantage to the products of the business ☐
Other (Specify) ____________________

18. Has your HACCP been audited externally, and if yes, by whom?

If yes, by: No ☐
Government ☐
International Organisations ☐
Private consultants / auditors ☐
Others (Specify)____________________

19. In your opinion what should be done to improve knowledge of HACCP?

Seminars from governmental agencies ☐
Seminars from private experts/consultants ☐
Publications from the Ministry of Health ☐
Use of internet ☐
Others (Specify)____________________

PART D

20. Give the reasons of not having the HACCP system implemented in your business at present.

It is not required for the type of process/business	☐
Nobody knows about HACCP in the company	☐
It costs too much money	☐
Other (Specify)	______________

Only for the answer "It costs too much money"

How much do you think it will cost?	______________	Euros

21. Are you planning to implement HACCP, if so when?

This year	☐	In two years time	☐
Next year	☐	After three years	☐

PART A

DETAILS ON MICROBIOLOGICAL HAZARDS

Table1

Characteristics of the main infection and intoxication causing bacteria

	Organism	
	Salmonella spp.	**L. monocytogenes**
Sources	Poultry, domestic and wild animals, man, insects, wilds birds	Soil, vegetation, man, sewage, water, animals-ubiquitous
Associated Foods	Raw milk, raw poultry, shell eggs, raw meat	Coleslaw, raw milk, soft cheese, raw meat, ice cream, vegetables
Importance	Common food poisoning. Severe symptom. Rarely fatal	Can grow slowly at refrigeration temperatures. Mortality rate 30% of those infected
Incubation Period	12-72 hours	8 days-3 months
Symptoms	Nausea, vomiting, abdominal pain, headache, chills, diarrhoea, fever. Last for 2-3 days	Flu-like illness to meningitis. May cause abortion to pregnant women
Gram (+,-)	Gram-negative	Gram-positive
Oxygen Requirements	Facultative anaerobe	Aerobe or microaerophilic
Growth Temperatures (°C)	Max: 45-47 Optimum: 37 Min: 5.1	Max: 45 Optimum: 25-30 Min: 0
pH range	Max: 9 Optimum: 6.5-7.5 Min: 4 -HCl/citric 4.4 – lactic 5.4 – acetic	Max: 9 Optimum: 7-7.5 Min: 4.4 at 30°C 5 at 5°C
Minimum a_w	0.95	0.92

Table 1 (cont'd)

	Organism	
	Shigella spp.	**Echerichia coli**
Sources	Polluted water and intestinal tracts of humans and other primates	Environment - soil, water, faeces/manure. Digestive tract of animals Raw milk, meat
Associated Foods	Milk and diary products, raw vegetables, poultry and salads	Raw milk, improperly processed or contaminated dairy products, raw meat
Importance	Severe cases caused by S. dysenteriae may result in septicaemia, pneumonia or peritonitis	Indicator of poor hygiene or improper processing. Several toxigenic strains producing heat-stable and heat-labile toxins
Incubation Period	12-48 hours	8-24 hours
Symptoms	Diarrhoea with bloody stools, abdominal cramps and fever. Slow recovery	Vomiting, fever, diarrhoea (sometimes bloody), stomach cramps, nausea
Gram (+,-)	Gram-negative	Gram-negative
Oxygen Requirements	Facultative anaerobe	Facultative anaerobe
Growth Temperatures (°C)	Max: 47 Optimum: 37 Min: 5	Max: 45.5 Optimum: 30-37 Min: 2.5
pH range	Max: 8-9.6 Optimum: 6.5-7.5 Min: 4-4.5	Max: 9.5 Optimum: 7 Min: 4.4
Minimum a_w	0.96	0.95

Table 1 (cont'd)

	Organism	
	Yersinia enterocolitica	**Vibrio parachaemoliticus**
Sources	Water, pigs, small rodents, pets	Seafood, coastal marine environments, intestines of marine animals
Associated Foods	Raw milk, ice cream, vegetables, raw pork	Seafood
Importance	Gives symptoms similar to appendicitis leading to unnecessary operations	Particularly important in raw seafood. It can be fatal
Incubation Period	1-10 days	4-96 hours
Symptoms	Diarrhoea, fever, vomiting, sharp pain in lower right side of abdomen	Acute gastroenteritis, nausea, vomiting, abdominal cramps, fever, chills, diarrhoea
Gram (+,-)	Gram-negative	Gram-negative
Oxygen Requirements	Facultative anaerobe	Facultative anaerobe
Growth Temperatures (°C)	Max: 44 Optimum: 32-34 Min: 0-1	Max: 43 Optimum: 37 Min: 12.8
pH range	Max: 9 Optimum: 7-8 Min: 4.6 at 25 °C 5 at 5°C	Max: 11 Optimum: 7.5-8.5 Min: 4.5-5
Minimum a_w	0.95	0.94

Table 1 (cont'd)

	Organism	
	Aeromonas hydrophila	**Clostridium perfrigens**
Sources	Freshwater, sewage, seawater	Soil, marine sediments, dust, faeces
Associated Foods	Seafood, red meat, poultry, raw milk	Ground beef, chicken, turkey, pork, dairy products
Importance	Immunocompromised patients at risk. Capable of growth at refrigeration temperatures. Two toxin types produced	Common food poisoning organism. Heat-resistant spores. Causes infection by heat-stable toxin formed during sporulation in gut
Incubation Period	Not known	8-24 hours
Symptoms	Diarrhoea, abdominal pain, vomiting, fever. May cause meningitis, septicaemia	Diarrhoea, nausea, flatulence
Gram (+,-)	Gram-negative	Gram-positive
Oxygen Requirements	Facultative anaerobe	Anaerobe
Growth Temperatures (°C)	Max: 42 Optimum: 28 Min: 1-4	Max: 50 Optimum: 43-45 Min: 12
pH range	Min: 4 Max: 10	Max: 8.3 Optimum: 6-7.5 Min: 5
Minimum a_w	Not known	0.95

Table 1 (cont'd)

	Organism	
	Campylobacter jejuni	**Clostridium botulinum**
Sources	Soil, water, and farm waste. Digestive tract of animals. Poultry, meats and raw milk	Soil, fresh water sediments, animal faeces, vegetation
Associated Foods	Poultry, meats, raw milk	Improperly processed or contaminated canned foods, meat, fish, vegetables
Importance	One of the most important causes of diarrhoea in the world. Do not grow well in foods. Food is a vehicle of infection	Spores can survive extremes of heat, drying and chemical exposure. Toxin heat-labile but deadly
Incubation Period	48 hours - 1 week	<18-96 hours
Symptoms	Profuse diarrhoea (sometimes bloody), stomach cramps, nausea, dizziness, fever	Dizziness, blurred vision, inability to swallow, paralysis and death
Gram (+,-)	Gram-negative	Gram-positive
Oxygen Requirements	Obligate microaerophile	Anaerobic
Growth Temperatures (°C)	Max: 47 Optimum: 42-45 Min: 32	Max: 48 Optimum: 30-37 Min: 3.3 (non-proteolytic) 10 (proteolytic)
pH range	Max: 9-9.5 Optimum: 6.5-7.5 Min: 4.9-5.3	Max: 9 Optimum: 6.5-7 Min: 4.6 (non-proteolytic) 5 (proteolytic)
Minimum a_w	Not known	0.94 (proteolytic) 0.97 (non-proteolytic)

Table 1 (cont'd)

	Organism	
	Staphylococcus aureus	**Bacillus cereus**
Sources	Skin, skin glands and mucous membranes i.e. nose, throat, cuts, boils	Soil, vegetation, raw milk
Associated Foods	Fish, meat, milk, cheese, pasta	Rice, spices, meat, milk, vegetable products, nuts
Importance	Can easily passes to food by handling incorrectly. Forms heat-resistant toxin	Heat-resistant spores. Can form toxin in food (emetic or diarrhoeal) or by multiplication in gut (diarrhoeal)
Incubation Period	2-6 hours	Diarrhoea toxin: 6-15 hours Emetic toxin: 30 mins-6 hours
Symptoms	Nausea, vomiting and diarrhoea lasting 1-2 days	Nausea, vomiting and diarrhoea
Gram (+,-)	Gram-positive	Gram-positive
Oxygen Requirements	Facultative anaerobe	Facultative anaerobe
Growth Temperatures (°C)	Max: 48 Optimum: 37 Min: 7-11	Max: 49 Optimum: 30 Minimum: 10
pH range	Max: 9.8-10 Optimum: 6-7 Min: 4	Max: 9.3 Optimum: 6-7.5 Min: 4.35
Minimum aw	0.86 (generation time 300 min, optimum aw: 0.98)	0.912

Table 2

Characteristics of the principal parasitic infections

Phylum	Species	Illness produced in man	Principal symptoms	Principal source of infection	Intermediate animal host
Protozoa (Single-celled organisms)	Entamoeba histolytica	Amoebic dysentery	Variable. May be limited to diarrhoea but in severe cases ulceration of organs of the body and possible death	Vegetables and fruits contaminated by handlers, flies etc. Contaminated water.	None
	Toxoplasma gondii	Toxoplasmosis	Hydrocephalus and blindness in children. Less severe in adults, often chronic with possible involvement of eyes.	Undercooked or meats (pork, lamb, beef and poultry). Domestic cats.	Domestic cats

Table 2 (cont'd)

Phylum	Species	Illness produced in man	Principal symptoms	Principal source of infection	Intermediate animal host
Trematodes (Non-segmented flatworms, the flukes)	<u>Fasciola hepatica</u>	Fascioliasis	Inflammation, abscesses and haemorrhages in the intestines.	Watercress	Snail and sheep or cattle.
	<u>Clonorchis sinensis</u>	Lonorchiasis	Infections of bile duct, gall bladder and liver.	Undercooked or raw freshwater fish.	Snails and freshwater fish.
Cestodes (segmented flatworms, the tapeworms)	<u>Taenia solium</u> <u>Taenia saginata</u>	Taeniasis	Loss of weight and severe symptoms of vomiting, abdominal pain and, in extreme cases, death.	Undercooked pork (Taenia solium) Undercooked beef (Taenia saginata)	Pigs (T. solium) Cattle (T. saginata)
	<u>Diphyllobothrium latum</u>	Diphyllobothriosis	Asymptomatic in 50% of cases. Diarrhoea, vomiting and dizziness in remainder.	Undercooked or raw fish	Freshwater fish and water-fleas

Table 2 (cont'd)

Phylum	Species	Illness produced in man	Principal symptoms	Principal source of infection	Intermediate animal host
Nematodes (Long, cylindrical unsegmented worms, the roundworms)	Trichinella	Trichinosis	Majority of cases asymptomatic. In others vomiting and diarrhoea, in first few days. Followed by muscular pains, oedema and fever.	Undercooked pork or pork sausages.	Pigs
	Anisakis sp.	Anisakis or "herring-worm" disease	Variable. May be limited to stomach pains and vomiting. Stomach ulcers in severe cases.	Undercooked or raw fish often lightly salted.	Marine fish including herring.

(a) Infection-causing bacteria

1. Salmonella spp.

Sources and characteristics

The bacteria are commonly present in raw meats, poultry, eggs, fish, milk and products made with them. They are in the droppings of animals (dogs, cats, cows and sheep) infected with Salmonella. They may be in untreated stream water. The faeces of infected humans contain Salmonella bacteria. Salmonella bacteria multiply rapidly in room temperatures. They are facultative bacteria. Only a small amount of Salmonella bacteria (20) is required to cause disease (Loken, 1995).

Two principal types of disease can be caused in human beings (Harrigan & Park, 1991):

- Enteric fever, which is the syndrome usually found in infections by Salmonella typhi and Salmonella paratyphi and
- Salmonella food poisoning, which is the syndrome occurring after infections of Salmonella enteritis bacteria.

Humans become infected after the consumption of food or drinking beverages that have been contaminated with faeces from people or animals that are infected with Salmonella bacteria.

Symptoms of the disease

Salmonella enteritis is the most important species of the Salmonella group. The symptoms include diarrhoea, fever, abdominal cramps and sometimes nausea and vomiting. In elderly, infants and immunocompromised individuals Salmonella can be fatal. The incubation period is 6-72 hours with an average of 12-36 hours. The disease lasts 2-3 days.

Preventive measures

The measures for the prevention of Salmonellosis are the following:

- Education of food handlers and public on good food hygiene practices that should be followed during handling food,
- Exclude from work until recovery food handlers with diarrhoea,
- Adequate cooking, re-heating and cooling of foods and
- Adequate cleaning of all the working place and surfaces

2. Listeriosis

There are five species of Listeria, but only one species, Listeria monocytogenes, has been implicated in food poisoning.

Sources and characteristics

Listeria monocytogenes bacteria have been associated with foods like raw milk, cheese, ice cream, raw vegetables, meat, poultry and smoked fish. The bacteria are able to grow at temperatures as low as 0°C permitting their multiplication in refrigerated foods (Mortimore & Wallace, 1994). They are quite hard and resist effects of freezing, drying and heat. It should be noted that Listeria monocytogenes does not form spores.

Outbreaks of listeriosis have been reported associated with ingestion of raw or contaminated milk, soft cheeses, contaminated vegetables and ready to eat meats (American Public Health Association, 1995).

Symptoms of the disease

Listeria monocytogenes is a dangerous microorganism and causes listeriosis with flu-like symptoms including persistent fever. Nausea, vomiting and diarrhoea may precede more serious forms of listeriosis. When listeric meningitis occurs, the overall mortality rate may be as high as 70%. Infections during pregnancy are led to spontaneous abortion or stillbirth while the mother usually survives. The onset of the disease is unknown, but is probably 1-3 weeks.

The high-risk groups are pregnant women, immunocompromised individuals, and cancer patients, infant and elderly people.

Preventive measures

The measures for the prevention of Listeriosis are the following:

- Pregnant women and immunocompromised individuals should eat only properly cooked meats and pasteurised dairy products,
- Ensure safety of foods of animal origin. Pasteurisation of all dairy products is important in minimising the risks from listeriosis foodborne disease,
- Adequate cooking, re-heating and cooling of foods,
- Avoidance of using untreated manure on vegetable crops and
- Thoroughly washing of raw vegetables before eating.

3. Escherichia coli

E. coli can be used as an indicator of hygiene standard of various processes. Its presence indicates that the hygienic practices have not been followed during the preparation and handling of food.

There are six categories of strains of Escherichia coli that cause diarrhoea (American Public Health Association, 1995) and have been associated with foodborne disease. These are a) enterohaemorrhagic, b) enteroinvasive, c) enteropathogenic, d) enteroaggregative and e) diffuse-adherent.

Sources and characteristics

Escherichia coli 0157:H7 is mainly found in beef meat. Other sources of the bacterium include raw milk and animals like pigs, poultry and lambs (Doyle, 1989).

Transmission occurs by ingestion of contaminated food, most often inadequately cooked beef (especially ground beef) and also raw milk. Transmission also occurs directly from person to person in families or in childcare centres. Waterborne transmission can also occur (American Public Health Association, 1995). Only a small number of the bacterium can cause disease.

Symptoms of the disease

The illness is characterised by severe cramping (abdominal pain) and diarrhoea which is initially watery but becomes grossly bloody. Occasionally vomiting occurs. Fever is either low-grade or absent. The illness is usually self-limited and lasts for an average of 8 days. Some individuals exhibit watery diarrhoea only.

E. coli 0157:H7 has a high fatality rate among the very young and elderly.

Preventive measures

As the bacterium is found in the intestinal tract of cattle and likely other animals used in the production of food, raw foods of animal origin may be contaminated through faecal contact during slaughter or milking procedures.

Measures likely to reduce the incidence of illness include the following:

- Manage slaughterhouse operation to minimise contamination of meat by animal intestinal contents,
- Pasteurise milk and dairy products,
- Heat beef adequately during cooking, especially ground beef to a temperature of 68°C and
- Protect, purify and chlorinate public water supplies and chlorinate swimming pools.

4. **Shigella dysenteriae**

Sources and characteristics

The bacterium is found in polluted water and in the intestinal tracts of humans and other primates. Associated foods include milk and milk products, raw vegetables, poultry and salads.

Food becomes contaminated when a human carrier with poor personal hygiene handles liquid or moist food that is then not cooked thoroughly.

Symptoms of the disease

The symptoms of the disease are diarrhoea with bloody stools, abdominal cramps and fever. Sometimes, vomiting is a symptom of the disease. In severe cases, septicaemia, pneumonia or peritonitis may be present.

The onset of the disease starts 12-48 hours after humans become infected and the recovery is slow.

Preventive measures

The preventive measures of Shigellosis include:

- The disposal of human faeces in a sanitary manner and maintain fly-proof latrines,
- The protection, purification and chlorination of the public water supplies,
- The control of flies by screening, spraying with insecticides and the use of insecticidal baits and traps,
- The cleanliness in food preparation and handling, the storing of food at refrigeration temperatures. Particular attention should be directed to the proper storage of salads and other food which is served cold,
- The enforcement of suitable quality control procedures in food and drink industries and
- The limiting of the collection and marketing of shellfish to suppliers from approved sources.

5. Yersinia enterocolitica

Source and characteristics

It is a psychrophile microorganism and can grow and multiply at temperatures as low as 0°C (Tzia and Tsiapouris, 1996). It is found in water, pigs, small rodents and in pets. The associated foods are raw milk, ice cream, vegetables and raw pork.

As it grows at refrigeration temperatures, then much attention should be given during the processing of foods that may be contaminated with the bacterium and will not have undergone any thermal processing.

Faecal-oral transmission takes place by eating and drinking contaminated food or water or by contact with infected people or animals.

Symptoms of the disease

The symptoms are diarrhoea, fever, vomiting and sharp pain in lower right side of the abdomen. Bloody diarrhoea is seen in 10-30% of infected children with Y. enterocolitica. The incubation period is 1-10 days.

Preventive measures

The preventive measures that should be applied to reduce the incidence of the disease are:

- Preparation of meat and other foods in a sanitary manner, the avoidance of eating raw pork,
- Washing of hands prior to food handling,
- Protection of water supplies from animal and human faeces,
- Disposal of human, dog and cat faeces in a sanitary manner and
- During the slaughtering of pigs, the head and neck should be removed from the body to avoid contaminating meat from the heavily colonised pharynx.

6. Vibrio parachaemoliticus

Sources and characteristics

It is an important microorganism as it is associated with seafood. It is naturally found in seafood, coastal marine environment and in the intestines of marine animals.

The bacterium is heat-sensitive, so Vibrio parachaemoliticus poisoning may result after the consumption of raw food or cooked food which has been cross-contaminated after cooking.

Symptoms of the disease

It causes an acute gastroenteritis where the symptoms are nausea, vomiting, abdominal cramps, fever chills and diarrhoea. The incubation period is 4-96 hours. In some cases, it may me fatal.

Preventive measures

The main preventive measures of V. parachaemoliticus are:

- Education of consumers about the risks associated with eating raw seafood and
- Education of seafood handlers and processors on the following preventive measures:
    - Assure that cooked seafood reaches temperatures adequate to kill the organism by heating for 15 minutes at 70°C,
    - Handle seafood in a manner that precludes contamination from raw seafood or contaminated seawater and
    - Keep all seafood, raw and cooked adequately refrigerated, before eating.

7. Vibrio cholerae

Sources and characteristics

Vibrio cholerae is known mainly as the cause of waterborne epidemics of cholera. Fish and shellfish harvested from waters contaminated by human sewage are the main sources of contamination.

The disease occurs through the ingestion of food or water contaminated directly or indirectly with faeces or vomitous of infected persons. Most cases of infection follow the ingestion of raw or inadequately cooked seafood.

Symptoms of the disease

The symptoms are persistent diarrhoea, abdominal cramps and fever. Diarrhoea usually lasts 7 days and is self-limiting. Symptoms can range from mild and uncomplicated to fatal. The incubation period is 1-3 days.

Preventive measures

The preventive measures of V. cholerae include:

- The disposal of human faeces in a sanitary manner and maintain fly-proof latrines,
- The protection, purification and chlorination of the public water supplies,
- The control of flies by screening, spraying with insecticides and the use of insecticidal baits and traps,
- The cleanliness in food preparation and handling, the storing of food in refrigerator temperatures. Particular attention should be directed to the proper storage of salads and other food is served cold,
- The enforcement of suitable quality control procedures in food and drink industries and
- The limiting of the collection and marketing of shellfish to supplies from approved sources.

8. Aeromonas hydrophila

Sources and characteristics

It is naturally found in freshwater, sewage and seawater. It is associated with foods like fish and shellfish, red meat, poultry and raw milk. Aeromonas is capable of growth at refrigeration temperatures.

Foods of animal origin that are consumed raw or undercooked are the most probable sources of infectious doses of Aeromonas hydrophila.

Aeromonas hydrophila produces two types of toxin, the cytotoxin and the haemolysin.

Symptoms of the disease

The symptoms of the disease include diarrhoea (sometimes bloody), abdominal pain, vomiting and fever. The immunocompromised patients are characterised as high-risk group.

Preventive measures

As Aeromonas hydrophila can survive refrigeration temperatures, storage of foods in refrigerators, by itself, is not an adequate means of preventing foodborne illness due to this bacterium. The heat treatment of foods is the best way of preventing Aeromonas hydrophila foodborne cases.

9. Clostridium perfringens

Sources and characteristics

It is an anaerobic, sporeforming bacterium and is normally found in soil, marine sediments, dusts and faeces. The associated foods are ground beef, chicken, turkey, pork and dairy products.

In most instances, the actual cause of poisoning by C. perfringens is temperature abuse of prepared foods. Small numbers of the organisms are often present after cooking and multiply to food poisoning levels during cool down and storage of prepared foods. The bacteria then form and release an enterotoxin as they sporulate in the gut.

Outbreaks are usually traced to food-catering firms, restaurants and cafeterias that have inadequate cooling and refrigeration facilities for large-scale service. Heavy bacterial contamination (>10^5 organisms per gram of food) is usually required for clinical disease (American Public Health Association, 1995).

Symptoms of the disease

The symptoms are abdominal pain, diarrhoea, sometimes nausea and vomiting. They last a day or less and are usually mild. The disease may be serious in infants, elderly and immunocompromised individuals. The incubation period is 8-22 hours.

Preventive measures

The preventive measures of the disease are:

- The education of food handlers of the risks inherent in large-scale cooking, especially of meat dishes and
- The service of hot dishes, as soon as they are cooked or if this is not possible, the rapid chilling and storage in the refrigerator until serving time. If the prepared dishes will be reheated the meat should reach an internal temperature of at least 70°C.

10. Campylobacter jejuni

Sources and characteristics

The bacteria are naturally found on poultry, cattle and sheep and can contaminate the meat and the milk of these animals. Raw poultry, meat and milk are often associated with campylobacteriosis.

The disease is transmitted:

a) By ingestion of the organisms in undercooked chicken and pork, contaminated food and water or raw milk and,

b) From contact with infected pets, farm animals or infected infants.

Contamination of milk occurs from faecal-carrier cattle, whereas people and food can be contaminated from poultry, especially from common cutting boards.

Symptoms of the disease

The symptoms of the disease are fever, headache, abdominal cramping and bloody stools. The incubation period is 2-5 days and lasts 2-5 days.

Preventive measures

In order to prevent cases of Campylobacter jejuni to occur, the following measures should be taken:

- Cook thoroughly all foodstuffs derived from animal sources particularly poultry. Avoid recontamination from uncooked foods within the kitchen after cooking is completed,
- Implement comprehensive control programmes and hygienic measures to prevent spread of organisms in poultry and animal farms and
- Minimise contact with poultry and its faeces.

(b) Intoxication-causing bacteria

1. Clostridium botulinum

Sources and characteristics

Clostridium botulinum is an anaerobic, gram-positive spore-forming rod. It is the causative agent of botulism. It is naturally found in soil, fresh and marine waters and their sediments and in fishes. Improperly processed or contaminated canned foods, meat, fish and vegetables are associated in botulism poisoning.

Growth of Clostridium botulinum in food leads to the formation of spores and subsequently to toxin formation. The spores of the bacterium are highly resistant to heat and survive boiling and higher temperatures while the toxins are not heat resistant. The toxins, which are present in the food before ingestion, are normally absorbed in the small intestine, transferred via the blood stream and finally absorbed into the nervous system. The toxins are highly poisonous and are characterised as neurotoxins since their action is specifically directed to nerves.

Symptoms of the disease

The symptoms usually appear 18-36 hours after the ingestion of food containing the toxin. The first symptoms are usually nausea, vomiting and possibly diarrhoea accompanied with fatigue, headache and dizziness. A further symptom is the persistent constipation, accompanied by blurred vision and difficulty in swallowing and speaking. In the more severe cases the involuntary muscles become paralysed and the paralysis spreads to the respiratory system and heart, death finally resulting from respiratory failure or cardiac arrest. The mortality rate in the United States is up to 65%, but in European countries is generally much lower (Forsythe & Hayes, 1998).

Preventive measures

The following should be done to prevent cases of botulism from occurring:

- Ensure effective control of processing and preparation of commercially canned and preserved foods,
- Educate those concerned with home food preparation techniques regarding the proper time and temperature required to destroy spores, the need for adequately refrigerated storage of incompletely processed foods and the effectiveness of boiling, with stirring, home-canned vegetables for at least 10 minutes to destroy botulinal toxins and
- Bulging containers should not be opened and foods with off-odours should not be eaten or "taste-tested". Commercially cans with bulging lids should be returned to the vendor.

2. Staphylococcus aureus

Source and characteristics

Staphylococcus aureus is a Gram-positive, non-motile microorganism. It is a facultative anaerobic growing better in the presence of air with an optimum temperature of around 37°C. Some strains of Staphylococcus aureus produce enterotoxins which are very heat resistant.

The most important source of Staphylococcus aureus is the human body, the physical reservoir being the nose. Between 30-40% of healthy individuals carry the bacterium (Forsythe & Hayes, 1998) and many of these nasal carriers inevitably also harbour the organism on their hands and other parts of the body. Animals can also be important sources of Staphylococcus aureus. As dairy cows carry the organism on the udder and teats, then milk becomes infected. Another way of spreading the microorganisms is through the milking equipment and the hands of workers.

According to the statistics, Staphylococcus aureus only accounts for 0.5-1% of food poisoning cases in UK (Forsythe & Hayes, 1998). However, this percentage may be higher as many cases are not reported due to the relatively mild symptoms.

Generally all foods that have been handled by a Staphylococcal carrier and subsequently stored under warm conditions for lengthy periods are the main cause of Staphylococcal poisoning. Such foods may include ham, meats and poultry, egg products such as custards and other confectionery products.

The disease is caused after the ingestion of heavily contaminated food. Food should contain thousands of Staphylococcus bacteria resulting in food poisoning.

Symptoms of the disease

The symptoms appear within 1-6 hours with an average of 3 hours. The most predominant and severe symptom is vomiting which is preceded by a feeling of nausea. Other common symptoms are abdominal cramps, and diarrhoea. The symptoms usually last for 1-2 days and mortality is extremely low although fatal cases have been reported (Forsythe & Hayes, 1998).

Preventive measures

The following measures can prevent the occurrence of Staphylococcal food poisoning:

- Education of food handlers in strict food hygiene, sanitation and cleanliness of kitchens, proper temperature control, handwashing cleaning of fingernails; and to the danger of working with exposed skin, nose and eye infections and the need to cover wounds,
- Reduction of food handling time (initial preparation to service) to an absolute minimum, with no more than 4 hours at ambient temperature. Perishable foods

should be kept hot (>60°C) or cold (<10 °C) in shallow containers and covered, if they are to be stored for more than 2 hours and

- Exclusion of people with boils, abscesses and other lesions of hands, face or nose from food handling.

3. Bacillus cereus

Sources and characteristics

Bacillus cereus is a Gram positive, facultative anaerobe, spore-forming rod. The spores are very heat resistant. Two different toxins can be produced by Bacillus cereus causing the "diarrhoeal" and "vomiting syndrome" respectively.

Bacillus cereus is naturally found in soil and water and can be readily isolated from a variety of plant foods including cereal dishes, mashed potatoes and vegetables.

The food poisoning occurs when contaminated food has not been cooked adequately, allowing the spores to survive. The subsequent warm storage result in spore germination and heavy growth of vegetative cells.

Symptoms of the disease

In the case of the "diarrhoeal food poisoning" the symptoms are characterised by acute abdominal pain and profuse diarrhoea. Nausea, vomiting and fever are rare and the symptoms last for less than 24 hours. The incubation period is about 6-15 hours. The symptoms of the "emetic food poisoning" are usually acute nausea, and vomiting, while diarrhoea is comparatively rare. The duration of the illness is from 6 to 24 hours. The incubation period is from 30 minutes to 6 hours.

Preventive measures

Food should not remain at ambient temperature after cooking, since the ubiquitous B. cereus spores can survive boiling, germinate and multiply rapidly at room temperature. Leftover food should be refrigerated promptly and should be reheated thoroughly and rapidly to avoid multiplication of microorganisms.

PART B
DETAILS ON CHEMICAL HAZARDS

1. Mycotoxins

Mycotoxicoses are caused by the ingestion of poisonous metabolites (mycotoxins) which are produced by fungi growing in food. Among some of the better-known and studied groups of mycotoxins are the aflatoxins. Aflatoxins are produced by certain strains of the fungi Aspergillus flavus and Aspergillus parasiticus. Under favourable conditions of temperature and humidity, these fungi grow and produce aflatoxins on certain foods like grains, nuts and feeds. There are four main aflatoxins designated B1, B2, G1 and G2 by the blue (B) or green (G) fluorescence given when viewed under a UV lamp. All are heat resistant and prolonged heating at 100°C is necessary to destroy their potency; they are unaffected by long-term storage, remaining stable in peanut butter stored at 23°C for over two years (Forsythe & Hayes, 1998).

The main target organ for aflatoxins is the liver where they can cause either tissue damage or tumours. In many animal species aflatoxin is highly active liver carcinogen and tumours may be produced by the administration of minimal amounts of aflatoxin (Forsythe & Hayes, 1998). However, there is not sufficient evidence that aflatoxins cause cancer to humans.

2. Scrombrotoxin

Scombroid poisoning or histamine poisoning occurs when foods that contain high levels of histamine are ingested. Histamine is produced by the microbial degradation of histidine, a free amino acid found in abundance in dark-fleshed fish, including members of the Scombridae family from temperate and tropical regions. Fish that have been temperature abused are the most commonly implicated foods. Other foods such as Swiss cheese have been reported to cause illness as well (Rhodehamel, 1992). Fish most often implicated in such incidents are mahi mahi, tuna, mackerel, and bluefish.

The toxin is produced within 3-4 hours, if the fish is left at room temperature. The symptoms of the disease are dizziness, vomiting, diarrhoea, difficulty in swallowing and large itchy red blotches on the skin. The symptoms usually disappear within 8-12 hours and fatalities are rare.

3. Mushroom toxins

Mushroom poisoning is caused by the consumption of raw or cooked fruiting bodies of certain higher fungi. Unlike the mycotoxins which are secondary metabolites produced when a contaminating mould grows on a food product, the mushroom itself is the toxic food product. Many species of mushrooms are toxic and there is no general rule to distinguish between edible and toxic species. Mushroom poisoning is usually caused by ingestion of toxic wild mushrooms that have been confused with edible species. Most mushrooms that cause human poisoning cannot be rendered non-toxic by cooking, canning or freezing. Mushrooms of the Amanita phylum are considered as poisonous. The most known poisonous species of that phylum include Amanita phalloides and A. muscaria (Forsythe & Hayes, 1998).

4. Shellfish toxins

Shellfish poisoning is caused by a group of toxins elaborated by planktonic algae upon which the shellfish feed. The shellfish may accumulate and metabolise these toxins during their filter feeding. There are four types of shellfish poisonings: paralytic shellfish poisoning (PSP), diarrhoeic shellfish poisoning (DSP), neurotoxic shellfish poisoning (NSP) and amnesic shellfish poisoning (ASP). The symptoms depend upon the toxin(s) present, their concentrations in the shellfish and the amount of contaminated shellfish consumed (Rhodehamel, 1992).

5. Polychlorinated biphenyls (PCBs)

PCBs are members of a group of organic compounds which have been used in a number of industrial applications. They are toxic and environmentally stable. The most significant source of PCBs in foodstuffs is through absorption from the environment by fish. PCBs then accumulate through the food chain and can be found in high levels in tissues with high lipid content.

Furthermore, the use of some packaging materials made of carcinogenic materials may allow the diffusion of these materials to enter the food.

6. Agricultural chemicals

Agricultural chemicals include pesticides, herbicides, fungicides, fertilisers, antibiotics and growth hormones which are set through expert toxicological studies. Many of these agricultural chemicals may leave residues which could be harmful in high concentrations.

For the consumer's protection, all countries have set maximum allowance levels in their laws and regulations. Furthermore, instructions for their use are given either from the producer or from government departments.

7. Prohibited substances

The direct or indirect use in food of such substances is prohibited because they present a potential risk to the public health or have not been shown by scientific data to be safe in human food. These substances are listed in the laws and regulations of each country.

8. Toxic elements and compounds

Toxic elements and compounds can enter food from a number of sources and can be of concern in high levels. The most significant sources of toxic elements to the food chain are (Mortimore & Wallace, 1994):

- Environmental pollution,
- The soil in which foodstuffs are grown,
- Equipment, utensils and containers for cooking, processing and storage,
- Food processing water and
- Chemicals applied to agricultural land.

Particular elements of concern are mercury in fish, cadmium and lead, both persistent environmental pollutants. Also significant are arsenic, aluminium, copper, zinc antimony and fluoride.

Toxic elements and other toxic compounds (e.g. some chemicals used in the food processing plant) are either not allowed in food at all or have established maximum tolerances.

9. Food Additives

Another category of chemicals is the food additives which gain entrance to the food direct or indirect. Preservatives, flavour enhancers, nutritional and colour additives are added directly in order to make products not only safe and hygienic but also to assist processing and to enhance or beatify them. Indirect chemicals such as lubricants, cleaners, sanitizers, paint and coatings, may become incorporated into food via migration from packaging materials, or microorganisms and enzyme preparations used in food processing.

In Europe, the Directive 89/107/EEC classifies additives according to their purpose and lays down guidelines and limitations for their use across various categories of foodstuffs.

PART C
DETAILS ON PHYSICAL HAZARDS

Table 1: Health effects and the sources of the physical hazards

MATERIAL	HEALTH EFFECTS	SOURCES
Glass	• Cuts to the mouth, bleeding • Serious consequences if swallowed/Choking • May require surgery to find and remove	• Bottles • Jars • Light fixtures • Thermometers • Gauge covers
Wood	• Cuts to the mouth and throat • Choking • May require surgery to remove	• Fruit / Vegetable / Grain • Pallets / Boxes • Buildings
Stones	• Dental damage • Choking • Sharp stones may cause cuts to the mouth and throat	• Fruit / Vegetable / Grain • Buildings
Metal	• Cuts to the mouth and throat • Choking	• Machinery / Building • Employees • Wire/Staples • Agricultural fields
Plastic	• Cuts • Choking • May require surgery to remove	• Agricultural fields • Packaging materials • Pallets • Employees • Production area
Pests	• Injury/Choking • Infections/Diseases	• Agricultural fields • Environment
Bones	• Injuries/Choking • May require surgery to remove	• Agricultural fields • Process
Personnel effects	• Cuts/Injuries/Choking • May require surgery to remove	• Employees

Methods of removal of physical Hazards

(a) Metal detectors

These can be used for the detection and removal of metals from foods. They have to be placed at the right point of the food production chain. A widely used method is the magnetic stick, but it has to be regularly cleaned. Another problem is that it cannot be used for the removal of aluminium, copper and stainless steel. Further, it cannot be used for the detection and removal of metals from already packed foods.

(b) X-ray detection devices

This method can be used for the detection and removal of almost all physical hazards. However, they are currently not widely used due to their high operation and maintenance costs.

(c) Floatation tanks and centrifugal separators

These two methods can be used to remove stones or other hard materials from the raw materials. It is a cheap and easy method.

(d) Sieves

If the process includes the dilution of a raw material into water or other liquid, then a sieve can be used to remove stones, glass, wood and other physical hazards that may be present.

(e) Visual inspection

The visual inspection is widely used in many food industries. Visual inspection can be used for the detection and removal of almost all physical hazards. However, the disadvantage of this method is that employee easily get distracted in the workplace by other activities going on around them such as the noise of the production line and fellow workers. The human attention span when carrying out tedious activities is short and the many physical hazards present in the food are missed.

The selection of the most suitable type of container in which raw materials and food will be packed is very important. Containers made from glass should be avoided whenever possible and should be kept out of the processing area. Where raw materials are delivered in metal or wooden containers, these should be carefully opened preferably outside the main production area. In Table 2b of this Part, the preventive measures on physical cross-contaminants are presented.

All equipment should be in such condition so as to prevent the contamination of food with physical hazards. Furthermore, all engineering work should be managed and parts should not be left unattended.

Table 2a

Preventive measures of the major intrinsic physical hazards of raw materials

Physical hazard	Preventive measures
Bone (fish, meat) Extraneous vegetable matter (fruit stones, stalks, pips, nutshells) Glass Wood Metal Plastic Pests	For liquids • Filtering • Magnets • Centrifugal separation For powders • Sifting • Magnets • Metal detection • Sir separation For flowing materials • Visual inspection • Screening/Sifting • Magnets • Metal detection • Washing • Stone and sand traps • Air separation • Floatation • Electronic colour sorting For solid items • X-ray, metal detection • Deboners • Visual inspection • Electronic scanning

Table 2b: Preventive measures of physical cross-contaminants

Physical hazard	Preventive measures
Glass	• Elimination of all glass except lighting. Lighting should be covered so as if they break cannot enter the food
Wood	• Exclusion of all wooden materials such as pallets, bushes, pencils, tools from exposed product areas • Segregation of packaging materials
Metal	• Maintenance of equipment to prevent contamination of food • Personnel should not wear jewellery • Exclusion from the production area of loose metal items like drawing pins, nuts and bolts, small tools • Use of metal detectors
Plastic	• Exclusion from the production area of plastic items like pen tops, buttons on overalls and jewellery
Pests	• Application of pest control programme including: i. Prevention (cleanliness, waste management) ii. Screening/proofing (mesh on doors and windows, air curtains) iii. Extermination (electric fly killers, baits)
Building fabric	• Design and maintenance of all the building fabric

INFORMATION ON THE STEPS 1 TO 5 OF THE HACCP SYSTEM IMPLEMENTATION

A. The following are the steps 1 to 5 that should be followed for the HACCP system implementation:

1. Assemble the HACCP Team

The HACCP Team is the team which is responsible for the preparation, development and application of the HACCP system. This team should consist of:

- **A food product development specialist** who is the person responsible for the final food quality and acceptability
- **A quality assurance / quality control specialist** who understands microbiological and chemical hazards and associated risks for a particular product
- **A production specialist** who is the production line manager and is able to contribute to what actually happens on the production line throughout all shift patterns
- **An engineer** who has a working knowledge of the hygienic design and engineering operation and performance of the process equipment which might be involved
- **Additional expertise** that can be persons both from within the company or from external consultancies.

After the set up of the HACCP Team, a member of the team should be appointed as the Team Leader. The Team Leader has a key role in the success of the HACCP System and he / she should be able to organise the team in order to have meetings to review the progress of the HACCP system on an ongoing basis.

The HACCP Team is also responsible for the development of the HACCP Plan. The HACCP Plan is a written document which describes the formal procedures to be followed in accordance with the seven principles. It may consist of a HACCP manual or working document, appropriate HACCP test methods, and a Master file containing all the background documentation and HACCP records. Any changes to the HACCP plan should be immediately reflected in the HACCP manual.

2. Describe the product

A full description of the product under study should be drawn up. The product should be defined in terms of its:

- Composition,
- Physical / chemical structure (including a_w, pH),
- Processing methods,
- Packaging system,
- Storage conditions and method of distribution,
- Required shelf life and
- Instruction for use.

3. Identify intended use

The consumer target group(s) should be defined. In specific cases, vulnerable groups of the population e.g. hospital patients, the very young and the elderly, may have to be considered.

4. Construct a flow diagram

The HACCP Team should construct the flow diagram, however, an externally sourced facilitator can be chosen. In such a case, he / she may bring a fresh approach to many problems, provided he / she is familiar with the operations being studied. An external specialist will also have no other conflicting roles within the operation.

The flow diagram should cover all steps in the operation. Its purpose is to provide a clear, simple outline of the steps involved in the process. The flow diagram can also include steps in the food chain that are before or after the processing that occurs in the establishment.

5. On-site confirmation of the flow diagram

The HACCP Team should confirm the processing operation against the flow diagram. It is important that the flow diagram is an accurate presentation of the operation including the hours of operation. It should be amended to take account of deviations found.

B. The following forms are used for the development and implementation of the HACCP system:

Form 1: Identification and evaluation of hazards

	Process step
Identify all hazards associated with the product	
Access severity of health consequences if hazard is not properly controlled	
Determine likelihood of occurrence of hazard if not properly controlled	
Using the above information, determine whether this hazard is to be addressed in the HACCP plan (significant hazard)	

Form 2: Preventive measures

Process step	Identified hazard	Preventive measures

Form 3: Decision tree answers (US NACMCF, 1997)

Process step and hazard	Q1	Q2	Q3	Q4	CCP?	HACCP Team notes

Form 4: Critical Control Points and Critical Limits

Process step	CCP No	Hazard	Preventive measure	Critical Limits

Form 5: Monitoring procedures and frequencies

Process step	CCP No	Hazard	Preventive measure	Critical Limits	Monitoring	
					Action	Frequency

Form 6: Corrective actions

Process step	CCP No	Hazard	Critical Limits	Monitoring		Corrective actions	Person Responsible
				Action	Frequency		

For a well-organised record keeping, the HACCP Team should develop the necessary forms. These forms are the following:

- Process Description Form,
- Product and Ingredients Form,
- Process Flow Diagram Form,

- Identification and Evaluation of Hazards Form,
- Preventive Measures Form,
- Decision Tree Answers Form,
- CCPs and Critical Limits Form,
- Monitoring procedures and frequencies Form and
- Corrective Action's Form.

All forms should contain at least the following information:

- Title and date of record,
- Product identification,
- Critical limits,
- A line for the monitor's signature,
- Time of observation and
- Place of the reviewer's signature.

C. Procedure in using the Decision Tree

(a) Question 1: Do preventive control measures exist for the identified hazard?

The answer to this question should be given after considering the measures which have already been in place at this step or those that could be implemented. This can be done using the Forms 2.2 and 2.3 which are expected to be filled in during the HACCP study. If the answer to this question is "yes" then the team should move to the next question. If however, the answer is "no" and preventive measures are not and could not be put in place, then the team should consider whether control is necessary at this point for food safety. If control is not necessary at this point (the answer to the question "Is control at this step necessary for safety" is "no") then a CCP is not required and the team should move on to the next hazard and start the decision tree again. In the case where the team answers "no" because there is control for this hazard later on, that control point further down in the process should be considered as critical (CCP). The metal detector is a good example of this loop as it might not be required at the early stages of the production line, but it is essential at the finished product stage.

If control at this point is essential while there are no preventive measure(s), then the process step or the process itself or the product should be modified so as preventive measures can be applied. In cases where modifications have been established, the team should start from the first question again.

(b) Question 2: Is the process step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?

What this question is really asking is whether the process step itself controls the hazard under consideration. The answer to this question should be given after the analysis of the technical information of the product (e.g. pH, a_w, preservatives).

If the answer is "yes", then this step should be set as a CCP and the team should proceed to the next process step or hazard. This question allows a degree of flexibility, which would otherwise be denied by question four. Thus if the answer is "yes", then it will be checked again when Question 4 would be answered for the same hazard.

If the answer is "no", then the team should proceed to the next question.

(c) Question 3: Could contamination with identified hazard(s) occur in excess of acceptable level(s) or could these increase to unacceptable level(s)?

First of all what constitutes acceptable and unacceptable levels of a particular factor should be set. Many times, in order to set these levels, expert advice should be sought by the team.

At this stage, it is important for the HACCP Team to take into account not only the possible increase of the identified hazard at this particular process step but also the additive effect of this hazard during a number of processes which will cause the increase of the hazard to unacceptable levels. A good example of this is Staphylococcus aureus and its toxins. When the process involves a number of steps being performed in ambient temperature, this might give the opportunity for a low initial contamination level to the bacterium to grow to toxin-forming levels and become a hazard.

The following issues should be taken into consideration by the team when answering the questions:

- Is the immediate environment likely to include the hazard?
- Is cross-contamination possible via personnel?
- Is cross-contamination possible from another product or raw material?
- Could composite time/temperature conditions increase the hazard?
- Are any other factors or conditions present which could cause contamination to increase to unacceptable level(s) at this step?

If the answer to the question is "yes", then the team should proceed to the next question. If however it is "no", then the team should start from the beginning of the decision tree with the next identified hazard or process step.

(d) Question 4: Will a subsequent step eliminate identified hazard(s) or reduce it to acceptable level(s)?

This question has a very important function to play when determining CCPs because it allows the presence of a hazard at a particular process step if that hazard will subsequently, either as a part of the operation or by some action of the end user, is controlled. In this way, the number of process steps regarded as CCPs is minimised focusing on those process steps which are crucial for product safety.

If no subsequent step(s) is (are) in place or scheduled in the process to control the hazard being considered, the answer should be "no" and this particular process step becomes a CCP.

If there is (are) subsequent step(s) later in the process that will eliminate the hazard being considered or reduce it to an acceptable level, the answer should be "yes". This process step is not a CCP but the subsequent step will be a CCP. An example of this situation is the correct consumer cooking which will control some of the microbiological hazards present in raw meat product. Similarly, the metal detection of finished products at the packing stage will detect metal contamination which may be a hazard associated with raw materials or an earlier process stage.

LIST OF PRACTICAL / FIELD WORK OF THE AUTHOR

The author had the following practical / field work:

- Two weeks (05-16/06/2000) work in E.B.I. Foods Limited sited in Abingdon, UK. The business was a breading-making factory. The author was a member of the HACCP Team that had reviewed the existing HACCP system,
- One week in the slaughterhouse of the RWM Food Group Ltd in Langport Somerset from 18-22/06/2001. The author co-supervised the HACCP system which was in place,
- One day (23/07/2001) in Sun Valley Foods Ltd. The author had an in-depth meeting with the HACCP team and discussed the HACCP system which was in place. He also had an on-site visit in the slaughterhouse,
- Two weeks (03-16/12/2001) training course at the Unit of Food, Water and Environmental Microbiology at the Laboratory of Clinical Bacteriology, Parasitology, Zoonoses and Geographical Medicine at the Medical School of University of Crete. During this course, the Crete study was conducted. The author visited the selected food businesses for the completion of the questionnaire,
- Two days (09-10/12/2002) in Hull City Council. The author had the opportunity to work with the Environmental Health Officers and visit a number of food businesses for sanitary inspection and HACCP auditing and
- Many visits to food businesses in Cyprus other than those businesses included in the Cyprus survey.

Seminars in Cyprus attended by the author

The author attended a series of seminars in Cyprus which were found very useful. These seminars were the following:

- "Principles and techniques of HACCP" conducted by Foodtech Laboratories Ltd on 30-31/01/2001 in Nicosia,
- "HACCP implementation and HACCP auditing" conducted by the Unit of Food, Water and Environmental Microbiology of the Laboratory of Clinical

Bacteriology, Parasitology, Zoonoses and Geographical Medicine of the Medical School of University of Crete between 12-13/03/2001 in Nicosia,

- “Training course on Hazard Analysis Critical Control Point (HACCP) system: concepts and applications”. This seminar was organised by the Veterinary Services of the Ministry of Agriculture, Natural Resources and Environment of Cyprus in collaboration with the IZSAM (Istituto Zooprofilattico Sperimentale dell’ Abruzzo e del Molice) between 27/02-03/03/2001 in Nicosia,
- “HACCP auditing” conducted by the National Food Centre of UK between 30-31/10/2002 and 01/11/2002 in Nicosia,
- “HACCP auditing” conducted by Highfield Publications, UK between 25-26/02/2003 in Nicosia and
- “HACCP Auditing” conducted by the National Food Centre of UK between 23-25/06/2003 in Nicosia.

RESULTS OF THE QUESTIONNAIRE OF THE PILOT SURVEY

PART A

1. Your age and gender

	Frequency	%		Frequency	%
Under 19	0	0	Male	37	92.5
Between 20-29 years old	8	20			
Between 30-39 years old	14	35			
Between 40-49 years old	13	32.5	Female	3	7.5
Between 50-59 years old	5	12.5			
Over 60	0	0			

2. What is your position in the business?

	Frequency	%
Owner of the business	14	35
Manager	14	35
Chef	6	15
Production line supervisor	1	2.5
F&B Manager	1	2.5
Quality Assurance Manager	2	5
Assistant Manager	2	5

3. For how many years do you have this position in this business?

	Frequency	%
Less than 1 year	3	7.5
Between 2-4 years	13	32.5
Between 5-7 years	7	17.5
More than 8 years	17	42.5

4. For how many years all-together do you work in the food/catering industry?

	Frequency	%
Less than 1 year	0	0
Between 2-4 years	4	10
Between 5-7 years	8	20
More than 8 years	28	70

5. What is your level of education on food hygiene/food safety?

	Frequency	%
Unqualified (Lyceum leaving certificate)	1	2.5
Basic (Induction training)	4	10
Intermediate (Food hygiene courses)	15	37.5
Advanced (College/University degree)	20	50

6. For how many years has your business operated?

	Frequency	%
Less than 2	3	7.5
Between 3-6	4	10
Between 7-10	9	22.5
More than 11	24	60

7. What is the main function of your business?

	Frequency	%
Hotel	11	27.5
Restaurant	9 (*)	22.5
Food manufacturing / processing industry	20	50

(*) There are Restaurants which also operate as takeaways.

PART B

8. a) What kinds of products are handled in the business and b) what main processes are employed?

A) Kind of products	Frequency	%
Raw meats	18	45
Raw poultry	18	45
Raw fish	17	42.5
Cooked meat	10	25
Cooked poultry	9	22.5
Cooked rice	9	22.5
Cooked fish	6	15
Egg/cream cakes	11	27.5
Egg products (mayonnaise)	8	20
Dairy products	18	45
Ready made sandwiches	2	5
Chilled ready meals	2	5
Meat products	3	7.5
Confectioneries' products	2	5
Bakeries' products	3	7.5
Fruits / Vegetables	2	5
Drinks / Juices	1	2.5
Soft	1	2.5
Nuts	1	2.5

B) Processes	Frequency	%
Grill	4	10
Canned	1	2.5
Chilling	8	20
Freezing	11	27.5
Drying	3	7.5
Frying	19	47.5
Roasting	27	67.5
Boiling	14	35
Baking	7	17.5
Smoking	3	7.5
Pasteurisation	6	16
Curing / Salting	5	12.5
Fermenting / Acidifying	6	15

9. What do you consider to be the hazards to public health imposed by the products handled in your business and how important are they?

	High level		Medium level		Low level		Not a hazard	
A) Microbiological hazards								
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Salmonella	22	55	7	17.5	1	2.5	10	25
Staphylococcus	17	42.5	3	7.5	5	12.5	15	37.5
E.coli	20	50	2	5	4	10	14	35
Clostridium botulinum	7	17.5	5	12.5	7	17.5	21	52.5
Bacillus cereus	9	22.5	5	12.5	6	15	20	50
Campylobacter jejuni	12	30	3	7.5	2	5	23	57.5
B) Chemical hazards								
Mycotoxins	9	22.5	5	12.5	9	22.5	17	42.5
Agricultural chemicals	7	17.5	7	17.5	7	17.5	19	47.5
Food additives	8	20	6	15	10	25	16	40
Metals	6	15	6	15	8	20	20	50
Veterinary residues	9	22.5	5	12.5	9	6	17	42.5
C) Physical hazards								
Pieces of metals, stones, glass, plastic, bones)	16	40	6	15	10	25	8	20

10. How many of your staff is involved in food handling in your business?

	Frequency	%
Less than 2	3	7.5
Between 3-5	11	27.5
Between 6-10	11	27.5
More than 11	15	37.5

11. Does the business employ temporary food handlers to assist at busy times of the year? (June-August, Weekends, Public Holidays)

	Frequency	%
Yes	15	37.5
No	25	62.5

12. Please indicate the number of the staff qualified in food hygiene/food safety at each of the following levels.

(For each member give only the most recent / advanced qualification)

	Total number of staff	Not trained		Basic/ Induction training		Intermediate/ Food hygiene and refresher courses		Advanced/ College, University degree	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
Full-time Food handlers	937	10	1	240	26	638	68	49	5
Temporary food handlers	19	6	32	13	68	0	0	0	0
Supervisors	45	0	0	4	9	34	75.5	7	15.5
Managers	40	0	0	5	12.5	15	37.5	20	50

Note: (The percentage is given based on the total number of staff)

13. Who provides the food hygiene training for your staff?

	Initial training	Refresher courses	Advanced courses
In-house staff	23	12	5
Health Inspectors of the Ministry of Health	13	13	1
Officers from the Ministry of Agriculture	1	4	0
External Consultants	2	0	1
Suppliers	1	0	0
Human Resource Development Authority	2	0	0
Municipality	1	0	0

14. Which of the following quality assurance systems is applied in your business?

	Frequency	%
ISO	9	22.5
Good Manufacturing Practices (GMP)	10	25
Total Quality Management (TQM)	4	10
Standard Sanitary Operation Procedures (SSOP)	12	30
"In-house" control of critical points	1	2.5
None	14	35

15. If the business operates such a quality assurance system, a) when did it start and b) when was it accredited?

	Starting	Accreditation
In 2000	1	2
In 1999	3	1
In 1998	2	0
In 1997	0	0
In 1996	0	5
In 1995	0	0
In 1994	1	1

16. Which of the following good hygiene practices are carried out by the business and how often are they carried out?

	Never		Once a day		Once a week		Once a month	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Cleaning schedules	0	0	40	100	0	0	0	0
Stock rotation (First-in, first-out principle)	0	0	38	97.5	1	2.5	1	2.5
Temperature monitoring of foods	4	10	30	75	5	12.5	1	2.5
Temperature monitoring of equipment	1	2.5	34	85	3	7.5	2	5
Microbiological testing (*)	19	47.5	7	17.5	2	5%	7	17.5

.../ continued

	Never		Once a day		Once a week		Once a month	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Inspection of raw materials	4	10	30	75	3	7.5	3	7.5
Checking health / illness of staff (**)	5	12.5	14	35	2	5	6	15
Reviews of good hygiene practices because of new products or suppliers (***)	12	30	12	30	1	2.5	11	27.5
Periodic checks that the hygiene policy is working (****)	2	5	15	37.5	3	7.5	12	30

(*): Plus 4: Every 6 months: 3, By Health Inspectors: 1, Twice a week: 1

(**) Plus 13: Food Handlers Health Certificate: 13

(***) Plus 4: When it is needed

(****) Plus 8: When it is needed: 4, Every 6 months: 3, Every year: 1

17. Are there written guidelines for carrying out these practices?

	Yes		Not now		In the future		Never	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Cleaning schedules	20	50	20	50	0	0	0	0
Stock rotation (First-in, first-out)	18	45	19	47.5	3	7.5	0	0
Temperature monitoring of foods	19	47.5	20	50	1	2.5	0	0
Temperature monitoring of equipment	18	45	21	52.5	1	2.5	0	0
Microbiological testing	9	22.5	28	70	3	7.5	0	0
Inspection of raw materials	17	42.5	23	57.5	0	0	0	0
Checking health/illness of staff	19	47.5	21	52.5	0	0	0	0
Reviews of good hygiene practices because of new products or suppliers	15	37.6	22	55	3	7.5	0	0
Periodic checks that the hygiene policy is working	16	40	22	55	2	5	0	0

PART C

18. Do you know what the Hazard Analysis and Critical Control Point (HACCP) system is?

	Frequency	%
Yes	31	77.5
No	9	22.5

19. Where did you obtain knowledge regarding the HACCP system?

	Frequency	%
Trade journal	8	20
External consultants	10	22.5
Colleges and Universities	14	35
Public Health Officers	3	7.5
Internet	10	22.5
Seminars	2	5

20. Is HACCP already in use?

Yes	Frequency
In 1996	1
In 1997	2
In 1998	3
In 1999	1
In 2000	1
Total number of businesses	8 (20%)

21. How did you implement HACCP?

	Frequency
With the aid of the government	1
With the aid of external consultants	6
On your own	1

22. How long did the implementation of the HACCP system take?

	Frequency
1-3 months	0
4-9 months	2
10 months -1 year	4
2 years	1
Development stage	1

23. Give the reasons why HACCP has been applied in your business (You may choose more than one answer).

(The percentage is based on the total number of establishments applying HACCP)

	Frequency	%
To increase the security and safety of your business	8	100
Due to customer pressure	1	12.5
Due to impending legal requirements	1	12.5
Having confidence in your product	5	62.5
To move accordingly to new trends or to give a commercial advantage	3	37.5

24. Is there a team responsible for the development, application and inspection of the HACCP system?

	Frequency
Yes	8
No	0

25. Did the team undergo formal training before the development and implementation of the HACCP system?

	Frequency
Yes	8
No	0

26. Does your HACCP system follow closely the documents of international bodies?

	Frequency
Yes	8
No	0

27. Is there external auditing for the HACCP system in place?

	Frequency
Yes	4
No	4

28. Did the HACCP system have been inspected / audited by the government and if so when?

	Frequency
1999	2
2000	1

29. Do you have HACCP training programme for your staff particularly your new staff?

	Frequency
Yes	8
No	0
In the future	0

PART D

30. Give the reasons of not having the HACCP system implemented in your business at present.

(The percentage is based on the total number of establishments not applying HACCP but the managers of which know what is HACCP)

	Frequency	%
It is not required for the type of process	2	9
Nobody knows about HACCP in the company	0	0
There is no legal obligation of implementing HACCP	14	6
It is difficult to apply in a business of your size	3	13
It is difficult to apply in this sector	1	4
It costs too much money	6	26
It is at the development Stage:	7	30

31. Are you planning to implement HACCP, if so when are you developing it?

	Frequency
This year	4
Next year	5
Not at all unless it is a legal requirement	14
In two years time	0
After three years	0

PART E

32. It is easy to get information on HACCP.

	Frequency	%
Strongly agree	0	0
Agree	10	25
Disagree	20	50
Strongly disagree	7	17.5
Neither agree/disagree	3	7.5

33. In your opinion what should be done to improve knowledge of HACCP? (You can choose more than one answer)

	Frequency	%
Visits at the business from government agencies	25	62.5
Seminars under the auspices of the government	31	77.5
Seminars from private experts/consultants	17	42.5
Establishment of governmental HACCP team	1	2.5

34. What actions are taken by your business when a complaint is made about food hygiene/food safety?

	Always		Sometimes		Rarely		Never	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Answer back to the complainer	33	82.5	1	2.5	0	0	0	0
Only recording	6	15	0	0	0	0	2	5
Action inside the business/ changes in production process	29	72.5	2	5	0	0	0	0
No action	0		0	0	0	0	0	0

35. How often does the Public Health Inspector visit your business for inspection purposes?

	Frequency	%
Not yet inspected	1	2.5
Once a week	3	7.5
Twice a year	16	40
Once a month	13	32.5
Once every three months	5	12.5
Every 2 months	1	2.5
Not in constant intervals	1	2.5

SUMMARY OF THE MAIN RESULTS OF THE CYPRUS SURVEY AND THE CRETE STUDY

CYPRUS SURVEY	CRETE STUDY
General	
• Health Certificate	• Health Certificate
• Most temporary food handlers are employed by catering businesses	• The same
• Most temporary food handlers are employed by businesses employing up to 4 full-time food handlers	• ----
Education – knowledge	
• Younger respondents have higher general education	• The same
• Owners were the least educated respondents	• The same, but the results are lower
• Lack of knowledge of microbiological, chemical and physical hazards	• The same
• Inadequate implementation of good hygiene practices (inspection of raw materials, temperature monitoring and microbiological testing)	• The same
• Higher education → better appreciation of the hazards	• The same
• Lower education → worse appreciation of the hazards	• The same
The HACCP system	
• Systems: o None: 4.7% o Common sense and experience: 46%	• Systems: o None: 10% o Common sense and experience: 16%

○ In-house designed systems: 26% ○ GMP: 9% ○ ISO: 14%	○ In-house designed systems: 22% ○ GMP: 6% ○ ISO: 46%
• Information about the HACCP system: ○ External consultants: 53.3% ○ Public Health Inspectors: 55% ○ Colleges and Universities: 29.7% ○ Other businesses: 6%	• Information about the HACCP system: ○ External consultants: 44% ○ Public Health Inspectors: 18% ○ Colleges and Universities: 34% ○ Other businesses: 46%
• Level of the HACCP system implementation: 17%	• Level of the HACCP system implementation: 44%
• More hotels and industry businesses have implemented the HACCP system than catering businesses	• The same
• The HACCP system was developed mainly by external consultants	• The same
• Officers from the government did not adequately helped food businesses to implement the HACCP system (take into account the dual role – educator and auditor)	• None business claimed that Officers from the Government has helped them to implement the HACCP system
• Reasons for implementing the HACCP system: ○ To increase the safety of their products: 94.1% ○ Customer pressure: 25.5% ○ Due to impending legal requirement: 23.5% ○ To give commercial advantage: 51%	• Reasons for implementing the HACCP system: ○ To increase the safety of their products: 100% ○ Customer pressure: 63.6% ○ Due to legal requirement: 68.2% ○ To give commercial advantage: 59.1% ○ Customer pressure had much

o Customer pressure had <u>little</u> general impact on the HACCP system implementation	general impact on the HACCP system implementation
• In hotels, it was the second reason for them to implement the HACCP system	• The same
• The smaller the size of the business the lower the level of the HACCP system implementation	• The same
• The larger the size of the business, the higher the possibilities to implement the HACCP system	• The same
• New businesses – less than 5 years old – were more likely to implement the HACCP system	• Up to 10 years old: The newer the business, the more likely to implement the HACCP system
• Businesses operated for more than 16 years were more likely to implement the HACCP system	• More than 10 years old: The older the business, the more likely to implement the HACCP system
• Positive correlation between the size of the business and the better appreciation of what the HACCP system is	• The same
• Barriers to implementing the HACCP system: o Lack of knowledge o Costs o Not legally required	• Barriers to implementing the HACCP system: o Lack of knowledge o Costs
• Development of the HACCP system:	• Development of the HACCP system:

Not at all if is not legally required – problem, they don't know its usefulness	Almost half of respondents: next year
• Governmental officials should play a more vital role in informing people about the HACCP system	• The same

BIBLIOGRAPHY

Ababouch L (2000). The role of government agencies in assessing HACCP. *Food Control Journal.* 11: 137-142

Allwood P B, Lee P and Borden-Glass P (1999). The vital role of restaurant health inspections. *Journal of Environmental Health.* 61(9): 25-29

Alreck L P and Settle B R (1995). *The Survey Research Handbook* (2nd Edition). Irwin/McGraw-Hill: Boston

Altekruse F S, Yang S, Timbo B B and Angulo J F (1999). A Multi-State Survey of Consumer Food-Handling and Food-Consumption Practices. *American Journal of Preventive Medicine*, 16(3): 216-221

American Public Health Association (1995). *Control of Communicable Diseases Manual.* (16th edition). American Public Health Association, Washington DC

Barnes J (2000). Implementation and enforcement in the United Kingdom In: Mayes T, Mortimore S (eds.) *Making the most of HACCP - learning from other experience.* Woodhead Publishing Limited, Abington pp 202-212

Barrett B, Penner K, Blakeslee K and Sauer K (1998). Hazard Analysis Critical Control Point training for foodservice operators in Kansas. *Dairy, Food and Environmental Sanitation Journal*, 18(4): 206-211

Barrow S J (1997). *Food Safety for Hotels and Restaurants.* HACCP International Ltd. New Theories Press, Oxford

Bauman H E (1992). Introduction to HACCP. In: Pierson M D and Corlett D A (eds.) *HACCP: Principles and Applications.* Chapman & Hall: New York, pp 1-5

Bauman E H (1993). Opinion: The origin of the HACCP system and subsequent evolution. *Food Science and Technology Today*, 8(2): 62-72

Bell J (1999). *Doing Your Research Project: A Guide for First-Time Researchers in Education and Social Science.* (3rd edition). Open University Press: Buckingham

Bernard D (1998). Developing and implementing HACCP in USA. *Food Control Journal.* 9(2-3): 91-95

Bowling A (1997). *Research Methods in Health.* Open University Press: Buckingham

Bruhn C M (1997). Consumer concerns: Motivation to action. *Emerging Infectious Diseases Journal.* 3(4): 511-516

Bryan F L (1999). Hazard Analysis Critical Control Point Approach to Food Safety: Past, Present and Future. *Environmental Health Journal*, April: 9-14

Buchanan R L (1995). The role of microbiological criteria and risk assessment in HACCP. *Journal of Food Microbiology.* 12: 421-424

Buchanan R L (1997). Identifying and Controlling Emerging Foodborne Pathogens: Research Needs. *Emerging Infectious Diseases Journal.* 3(4): 517-521

Buchert A, Cederberg T, Dyke P, Fiedler H, Furst P, Hanberg A, Hosseinpour J, Hutzinger O, Kuenen J G, Malisch R, Needham L L, Olie K, Papke O, Rivera Aranda J, Thanner G, Umlauf G, Vartiaimen T and van Holst C (2001). Dioxin contamination in food: Bayreuth, Germany, from September 28 to October 1, 2000. *Environmental Science and Pollution Research Journal.* 8(2): 84-88

Buttriss J (ed.) (2002). *Adverse Reactions to Food: the Report of a British Nutrition Foundation task force.* Blackwell Science: Oxford

Canadian Food Inspection Agency (1998). *Labelling of foods causing allergies and sensitivities.* [online] Canadian Food Inspection Agency.
Available from: www.inspection.gc.ca/english/bureau/inform/19980331be.shtml
[Accessed 9 January 2003]

Canadian Food Inspection Agency (2000). *Food Safety Enhancement Programme: Implementation Manual, Volume II: Guidelines and Principles for the Development of HACCP Generic Models.* (2nd ed) [online] Canadian Food Inspection Agency: Ontario
Available from:
http://www.inspection.gc.ca/english/ppc/psps/haccp/manu/vol2/vol2e.shtml
[Accessed 16 February 2002]

Chamber of Commerce and Industry of Heraklion (2002). *Crete: An Introduction General Description Macro-economic Data.* [online] Chamber of Commerce and Industry of Heraklion: Heraklion.
Available from: http://www.ebeh.gr/crete_en.html
[Accessed 3 November 2002]

Codex Alimentarius (Codex Alimentarius Commission, Joint FAO / WHO Food Standards Programme, Codex Alimentarius Committee on Food Hygiene) (1997). *General Requirements (Food Hygiene).* FAO / WHO: Rome

Codex Alimentarius (Codex Alimentarius Commission, Joint FAO / WHO Food Standards Programme, Codex Alimentarius Committee on Food Hygiene) (1999). *Discussion paper on HACCP in small and / or less developed businesses.* (CX/FH 99/9) FAO / WHO: Rome

Codex Alimentarius (Codex Alimentarius Commission, Joint FAO / WHO Food Standards Programme, Codex Alimentarius Committee on Food Hygiene) (2003). *Consideration of the obstacles to the application of HACCP, particularly in small and less developed businesses and approaches to overcome them* (CX/FH 03/4 - Add. 1, December 2003). FAO / WHO: Rome

Commission of the European Communities (2001). Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee: Community Strategy for Dioxins, Furans and Polychlorinated Biphenyls (COM (2001) 593 Final). European Community: Brussels

Conhran-Yantis D, Belo P, Giampaoli J, McProud L, Everly V and Gans J (1996). Attitides and knowledge of food safety among Santa Clara County California restaurant operators. *Journal of Foodservice Systems*. 9: 117-128

Department of Agriculture, Fisheries and Forestry of Australia (2001). *Food Safety and Quality Systems: A Business Perspective*. [online] Department of Agriculture, Fisheries and Forestry of Australia: Canberra
Available from: http://www.affa.gov.au/corporate_docs/publications/pdf/food/survey7-01.pdf
[Accessed 9 October 2002]

De Sitter H and Van de Haar S (1998). Governmental Food Inspection and HACCP. *Food Control Journal*, 9(2-3): 131-135

Dillon M and Griffith C (1996). *How to HACCP: An illustrated Guide* (2nd Edition). MD Associates: Grimsby

Dillon M (2001). Food standards and auditing. In: Dillon M and Griffith C (eds.) *Auditing in the food industry – from safety and quality to environmental and other audits*. Woodhead Publishing Limited, Abingdon pp.5-16

Dixon S (1999). Lecture notes on "Food Quality and Management of Consumer Risk". Intensive Course, University of Surrey

Donovan J A, Caswell J A and Salay E (2001). The effect of stricter foreign regulations on food safety levels in developing countries: a study in Brazil. *Review of Agricultural Economics Journal*. 23(1): 163-175

Doyle P M (Editor) (1989). *Foodborne Bacterial Pathogens*. Marcel Dekker Inc, New York and Basel

Ehiri E J, Morris P G and McEwen J (1997a). A survey of HACCP implementation in Glasgow: is the information reaching the target? *International Journal of Environmental Health Research*, 7: 71-84

Ehiri E J, Morris P G and McEwen J (1997b). Evaluation of a food hygiene training course in Scotland. *Food Control Journal*, 8(3): 137-147

European Food Safety Authority (2002). *About the European Food Safety Authority.* [online] European Food Safety Authority
Available from: http://www.efsa.eu.int/about_en.html
[Accessed 17/05/2002]

European Commission Statistical Service (Eurostat) (2002). *The life of women and men in Europe: A statistical portrait of women and men in all stages of life*. Report No 121/2002 of 8 October 2002. [online] European Commission Statistical Service
Available from: http://europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=3-08102002-EN-AP-EN&mode=download
[Accessed 3 November 2002]

Fencott C and Hebbron B D (1995). The application of HAZOP studies to integrated requirements models for control systems. *ISA Transactions Journal*, 34: 297-308

Fishbein L (1998). Transmissible spongiform encephalopathies, hypotheses and food safety: an overview. The Science of the Total Environment Journal, 217(1-2): 71-82

Food Standards Agency (2001). *Paper FSA 01/07/02: Strategy for a wider implementation of HACCP (Agenda item 4, 14 November 2001).* [online] Food Standards Agency: London
Available from: http://www.foodstandards.gov.uk/multimedia/pdfs/fsa_01_07_02.pdf
[Accessed 12 October 2002]

Food Standards Agency (2001). *About us.* [online] Food Standards Agency, London Available from: http://www.foodstandands.gov.uk/aboutus/
[Accessed 15 May 2002]

Food Standards Agency (2002). *Paper Note FSA 02/07/02: Strategy for a wider implementation of HACCP – update Report.* [online] Food Standards Agency: London Available from: http://www.food.gov.uk/multimedia/pdfs/note020702.pdf
[Accessed 12 October 2002]

Food Safety Authority of Ireland (2001). *Survey of the implementation of HACCP (Hazard Analysis and Critical Control Point) and Food Hygiene Training in Irish Food Businesses.* [online]. Food Safety Authority of Ireland: Dublin
Available from: http://www.fsai.ie/publication_list_index.htm
[Accessed 15 April 2002]

Forsythe J S and Hayes R P (1998). *Food Hygiene, Microbiology and HACCP.* (3rd Edition). An Aspen Publication: Gaithersburg, Maryland

Garrett E S and Hudak-Roos M (1991). Developing an HACCP-Based Inspection System for the Seafood Industry. *Food Technology Journal,* 45(12): 53-57

Gormley T R (1995). RTD needs and opinions of European food SMEs. *Farm and Food Journal.* 5:27-30

Greene J F, Hays S and Paustenbach D (2003). Basis for a proposed reference dose (RfD) for dioxin of 1-10 pg/kg-day: a weight evidence evaluation of the human and animal studies. *Journal of Toxicology and Environmental Health,* 6(2): 115-159

Griffith C J, Mathias K A and Price P E (1994). The mass media and food hygiene education. *British Food Journal.* 96(9): 16-21

Gunningham J C (1993). A survey of the Attitudes and Perceptions of Food Service Operators in the Hamilton – Wentworth Region. *Canadian Journal of Public Health*, 84(2): 107-111

Hall R L (1997). Foodborne illness: implications for the future. *Emerging Infectious Diseases Journal*. 3(4): 555-559

Hayes P R (1992). *Food Microbiology and Hygiene*. (Second Edition). Elsevier Science: London and New York

Harrigan F W and Park A W (1991). *Making Safe Food: A management guide for microbiological quality*. Academic Press Inc: San Diego CA 92101

Henson S and Holt G (2000). Exploring incentives for the adoption of food safety controls: HACCP implementation in the UK dairy sector. *Review of Agricultural Economics Journal*. 22(2): 407-422

Hobbs C B and Roberts D (1987). *Food Poisoning and Food Hygiene*. (5^{th} Edition). Edward Arnold Publishers: Great Britain

HMSO (1976). *Food Quality and Safety: a Century of Progress: Proceedings of the Symposium celebrating the Century of the Sale of Food and Drugs Act 1875*. Ministry of Agriculture, Fisheries and Food: London

Human Resource Development Authority (1995). *The restaurants in Cyprus: Human Resource Capabilities and Perspectives*. Human Resource Development Authority: Nicosia

Human Resource Development Authority (1999). *The Small and Medium Sized Businesses in Cyprus*. Human Resource Development Authority: Nicosia

Interkriti. *Geographical information*. [online] Interkriti: Grete
Available from: http://www.interkriti.org/intro.htm
[Accessed 16 November 2002]

International Commission on Microbiological Specifications for Foods (ICMSF) (1988). *Microorganisms in Foods 4: Application of the Hazard Analysis Critical Control Point (HACCP) System to Ensure Microbiological Safety and Quality.* Blackwell Science: Great Britain

Irwin K J, Ballard J and Kobayashi J (1989). Results of routine restaurant inspections can predict outbreaks of foodborne illness: The Seattle-King County experience. *American Journal of Public Health*, 79(5): 586-590

International Organisation of Standardisation (2000). *ISO 9000 series: Quality management systems - requirements.* International Organisation of Standardisation: Geneva

Jay M J (1996). *Modern Food Microbiology.* Chapman and Hall: New York

Jirathana P (1988). Constraints experienced by developing countries in the development and application of HACCP. *Food Control Journal.* 9(2-3): 97-100

Joneja V J M (2000). *Dietary Management of Food Allergies and Intolerances.* J. A. Hall Publications: Canada

Jouve L J (1994). HACCP as applied in EEC. *Food Control Journal.* 5(3): 181-186

Jouve L J (2000). Moving on from HACCP In: Brown M (ed.) *HACCP in the meat industry.* Woodhead Publishing Limited, Abington pp 293-317

Kanellopoulos N C (1996). Recent developments in Greek education. *International Journal of Educational Development.* 16(1): 65-77

Kennedy R and Kirwan B (1998). Development of a Hazard and Operability-based method for identifying safety management vulnerabilities in high risk systems. *Safety Science Journal.* 30: 249-274

Khandke N (2000). Auditing HACCP-based QA systems. *In*: Brown M (ed.) HACCP in the meat industry. Woodhead Publishing Limited, Abingdon pp 273-290

Krebs J R (2001). Science, uncertainty and policy: food for thought. Toxicology Letters Journal, 120 (1-3): 89-95

Kvenberg J, Stolfa P, Stringfellow D and Garrett E S (2000). HACCP development and regulatory assessment in the United States of America. *Food Control Journal.* 11: 387-401

Lee J A and Hathaway S C (1999). Experiences with HACCP as a tool to assure the export of food. *Food Control Journal.* 10: 321-323

Loken K J (1995). *The HACCP Food Safety Manual.* John Wiley & Sons: New York

Macdonald J D and Engel D (2001). *A guide to HACCP – Hazard Analysis for small businesses.* (2nd ed.) Highfield Publications, Doncaster

Mayes T (2000).Introduction. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience.* Woodhead Publishing Limited, Abington pp 1-8

McAloon T R (2000). HACCP implementation in the United States. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience.* Woodhead Publishing Limited, Abington pp 61-78

McEachern V, Bungay A, Ippolito Bray S, Lee-Spiegelberg S (2000). Enforcing safety and quality. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience.* Woodhead Publishing Limited, Abington pp 165-182

Mead P S, Slutsker L, Dietz V, McCaig L F, Bresee J S, Shapiro C, Griffin P M and Tauxe R V (1999). Food-Related Illness and Death in the United States. *Emerging Infectious Diseases Journal*, 5(5): 607-625

Meng J and Doyle M P (1997). Emerging issues in microbiological food safety. *Annual Review of Nutrition Journal*, 17: 255-275

Meng J and Doyle M P (1998). Emerging and evolving microbial foodborne pathogens. *Bull. Inst. Pasteur, 86: 151-164*

Meng J and Doyle M P (2002). Introduction: Microbiological food safety. *Microbes and Infection Journal*, 4: 395-397

Miles S and Frewer L J (2001). Investigating specific concerns about different food hazards. *Food Quality and Preference Journal*, 12(1): 47-61

Ministry of Health (2000a). *Public Health Services: Annual Reports for 1999.* Ministry of Health: Nicosia

Ministry of Health (2000b). *Annual Reports for 1988-1999.* Ministry of Health: Nicosia

Morrison P, Caffin N and Wallace R (1998). Small food establishments still amber light for adopting Australian HACCP-based food safety code. *British Food Journal*, 100(8): 364-370

Motarjemi Y and Kafestein F (1999). Food safety, Hazard Analysis and Critical Control Point and the increase in foodborne diseases: a paradox?. J*ournal of Food Control*, 10: 325-333

Mortimore S and Wallace C (1994). *HACCP, A practical approach.* Chapman and Hall: London

Mortimore S E (2001). How to make HACCP really work in practice. *Food Control Journal*, 12: 209-215

Mortlock P M, Peters C A and Griffith J C (1999). Food Hygiene and Hazard Analysis Critical Control Point in the United Kingdom Food Industry: Practices, Perceptions, and Attitudes. *Journal of Food Protection*. 62(7): 768-792

National Centre for Surveillance and Intervention (2000). Reported cases of infectious diseases. National Centre for Surveillance and Intervention, Athens
Available from http://www.ncsi.gr
[Accessed 29 August 2002]

Oppenheim A N (1992). *Questionnaire design, interviewing and attitude measurement*. Pinter Publishers: London

Panisello J P, Quantick C P and Knowles J M (1999). Towards the implementation of HACCP: results of a UK regional survey. *Food Control Journal*, 10: 87-98

Panisello P J and Quantick P C (2001). Technical barriers to Hazard Analysis Critical Control Point (HACCP). *Food Control Journal*. 12: 165-173

Papamatthaiou M (2002). 50000 students in Greek AEI. *To vima* (13694):A41, Sunday 20 October 2002

Papastephanou Ch. (2002). Vegetables displayed in open markets "loaded" with lead. *O Katanalotis (The Consumer)* (The Cyprus Consumer Association Magazine). 103: 4-7

Parzefall W. (2002). Risk assessment of dioxin contamination in human food. *Food and Chemical Toxicology Journal*. 40: 1185-1189

Pierson D M and Corlett A O (1992). Introduction to HACCP. In: Pierson M D and Corlett D A (eds.) *Hazard Analysis and Assignment of Risk Categories.* Chapman & Hall: New York, pp 29-38

Population Reference Bureau (1999). *World Population.* [online]
Available from: http://www.worldpop.org/prbdata.htm#wpds
[Accessed 20 August 2000]

Population Reference Bureau (2000). *World Population.* [online]
Available from: http://www.worldpop.org/prbdata.htm#wpds
[Accessed 17 July 2001]

Public Health Laboratory Service (1999). *Laboratory Reports to CDSC.* [online]
Public Health Laboratory Service: London
Available from: http://www.phls.co.uk
[Accessed 15 September 2000]

Rennie D (1994). Evaluation of food hygiene education. *British Food Journal.* 11: 20-25

Rhodehamel E J (1992). Introduction to HACCP. In: Pierson M D and Corlett D A (eds.) *HACCP: Principles and Applications.* Chapman & Hall: New York, pp 8-28

Rose D J (2001). TQM systems. In: Dillon M and Griffith C (eds.) *Auditing in the food industry – from safety and quality to environmental and other audits.* Woodhead Publishing Limited, Abingdon pp.70-91

Route N (2000). HACCP and SMEs: a case study. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience.* Woodhead Publishing Limited, Abington pp 32-41

Sanders A B T (1999). Food production and food safety. *British Medical Journal,* 318: 1689-1693

Schlundt J (1999). Principles of food safety Risk management. *Food Control Journal.* 10: 299-302

Scipioni A, Saccarola G, Centazzo A and Arena F (2002). FMEA methodology design, implementation and integration with HACCP system in a food company. *Food Control Journal.* 13: 495-501

Sheppard J M and Thomson J (1990). Hygiene and hazard analysis in food service. In: Cooper C (ed.). *Progress in tourism, recreation and hospital management* (vol. 2). Belhaven Press, London pp. 192-226

Sparling D, Lee J and Howard W (2001). Murgo Farms Inc.: HACCP, ISO 9000 and ISO 14000. *International Food and Agribusiness Management Review Journal.* 76: 203-206

Sperber W H (1998). Auditing and verification of food safety and HACCP. *Food Control Journal.* 9(2-3): 157-162

Sperber H W, Stevenson E K, Bernard T D, Deibel E K, Moberg J L, Hontz R L and Scott N V (1998). The role of prerequisite programmes in managing a HACCP system. *Dairy, Food and Environmental Sanitation Journal*, 18(7): 418-423

Sprenger A R (1993). *Hygiene for management: A text for food hygiene courses.* (6th ed.) Highfield Publications: London

Sprenger A R (2002). *Hygiene for management: Focus on food safety.* (9th ed.) Highfield Publications: Doncaster

SPSS Inc. (1998). *Statistical Package for Social Sciences (SPSS).* Version 9. SPSS Inc: Chicago

SPSS Inc. (2000). *Statistical Package for Social Sciences (SPSS).* Version 10. SPSS Inc: Chicago

Statistical Service of the Republic of Cyprus (1997). *Statistics of hotels and restaurants for 1996*. Printing Office of the Republic of Cyprus: Nicosia

Statistical Service of the Republic of Cyprus (2000a). *Statistics of hotels and restaurants for 1999*. Printing Office of the Republic of Cyprus: Nicosia

Statistical Service of the Republic of Cyprus (2000b). *Statistics of Education for the school-year 1999/2000*. Printing Office of the Republic of Cyprus: Nicosia

Statistical Service of the Republic of Cyprus (2001). *Tourism and Travel Statistics of December 2001*. [online] Printing Office of the Republic of Cyprus: Nicosia
Available from: http://www.pio.gov.cy/ddsr/press_releases/tourism/dec2001.html
[Accessed 5 April 2002]

Struijk B C (1996). The Hamlet option in food microbiology: to analyse or not to analyse food specimens as marketed once HACCP implemented. *Acta Alimentaria*, 25(1): 57

Sunjet (Inflight magazine of Cyprus Airways) *Catering Department Receives HACCP Certificate*. (March-April 2003)

Suwanrangsi S (2000). HACCP implementation in the Thai fisheries industry. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience*. Woodhead Publishing Limited, Abington pp183-200

Swann C D and Preston M L (1995). Twenty-five years of HAZOPs. *Journal of Loss Prevention in the Process Industries*. 8(6): 349-353

Swuste P, Goosens L, Bakker F and Schrover J (1997). Evaluation of accident scenarios in a Dutch steel works using a hazard and operability study. *Safety Science Journal*. 26(2): 63-74

Taylor E (2000). HACCP and SMEs: problems and opportunities. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience.* Woodhead Publishing Limited, Abington pp 13-30

Taylor E (2001). HACCP in small companies: a benefit or burden?. *Food Control Journal.* 12: 165-173

Tompkin R B (2001). Interactions between government and industry food safety activities. *Food Control Journal.* 12: 203-207

Tricker R (1997). *ISO 9000 for small businesses.* Butterworth-Heinemann, Oxford

Tzia C and Tsiapouris A (1996). *Risk Analysis of Critical Control Points (HACCP) in Food Industry.* Papasoteriou: Athens

Unnevehr L (2002). Food safety incentives in a changing world food system (editorial). *Food Control Journal.* 13: 73-76

U.S. Department of Health, Education and Welfare (1972). *Proceedings of the 1971 Conference on Food Protection.* U.S. Government Printing Office: Washington, DC

U.S. National Advisory Committee on Microbiological Criteria for Foods (1997). *Hazard analysis and critical control point principles and application guidelines: Adopted August 14, 1997.* FSIS: Washington, DC

US Food and Drug Administration (1999). *1999 Edition of FDA Food Code.* FDA Backgrounder No. BG 99-3 [online] Food and Drug Administration. Available from: http://www.fda.gov/opacom/backgrounders/foodcode.html [Accessed 20 January 2003]

U.S. Food and Drug Administration, Centre for Food Safety and Applied Nutrition. *Foodborne Pathogenic Microorganisms and Natural Toxins Handbook – Bad Bug*

Book – Escherichia coli 0157:H7. [online] U.S. Food and Drug Administration, Centre for Food Safety and Applied Nutrition
Available from: http://vm.cfsan.fda.gov/~mow/chap15.html
[Accessed 25 February 2000]

U.S. National Seafood HACCP Alliance (1993). *Seafood HACCP Training Manual.* [online] U.S. National Seafood HACCP Alliance
Available from:
http://nsgd.gso.uri.edu/source/ncue96001/Pncue96001_part_1.pdf
[Accessed 20 October 1999]

Voysey P A and Brown M (2000). Microbiological risk assessment: a new approach to food safety control. *International Journal of Food Microbiology*, 58: 173-179

Walker E and Jones N (2002). An assessment of the value of documenting food safety in small and less developed catering businesses. *Food Control Journal.*13: 307-314

Walker E, Pritchard C and Forsythe, S (2003). Hazard Analysis critical control point and prerequisite programme implementation in small and medium size food businesses. Food Control Journal. 14: 169-174

Wallace C (2000). Effective HACCP training. In: Mayes T and Mortimore S (eds.) *Making the most of HACCP – learning from others' experience.* Woodhead Publishing Limited, Abington pp 213-230

WHO (1984). *The role of food safety in health and development: Report of a joint FAO/WHO expert committee on food safety.* (Technical Report Series 705), WHO: Geneva

WHO (1993). *Training Considerations for the Application of the Hazard Analysis Critical Control Points System to Food Processing and Manufacturing.* (WHO/FNU/FOS/93.3, Division of Food and Nutrition). WHO: Geneva

WHO (1998a). *Data bank on Foodborne Disease Outbreaks*. WHO: Geneva

WHO (1998b). *Guidance on Regulatory Assessment of HACCP* (WHO/FSF/FOS/98.5) (Report of a Joint FAO/WHO Consultation on the role of Government Agencies in Assessment HACCP). WHO: Geneva

WHO (1999). *Strategies for implementing HACCP in Small and / or Less Developed Businesses*. (WHO/SDE/PHE/FOS/99.7) (Report of a WHO Consultation in collaboration with the Ministry of Health, Welfare and Sports, The Netherlands). WHO: Geneva

WHO (2001). *Backgrounder Paper: Developing a Food Safety Strategy*. (Draft Report of the WHO Strategic Planning Meeting). [online]. WHO: Geneva
Available from: http://www.who.int/fsf/Documents/BACKGROUND%20PAPER.pdf
[Accessed 26 October 2002]

Williams A P, Smith R A, Gaze R, Mortimore S E, Motarjemi Y and Wallace C A (2003). An international future for standards of HACCP training. *Food Control Journal*. 14: 111-121

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